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JAPAN

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TELECOMMUNICATIONS

/9987

EXPANDED VSRA FUNCTION DESCRIBED

Tokyo KOGIKEN NYUSU in Japanese Oct 86 pp 1-2

[Text] The Beechcraft B-65, the experimental aircraft of NAL (National Aerospace Laboratory), has been used as an in-flight simulator since 1979 when the original aircraft was modified to a VSRA (variable-stability and response airplane) equipped with a digital fly-by-wire system using a microcomputer.

A computer system is mounted on the VSRA, and an experimental aircraft automatically controls this aircraft so that a model aircraft such as a jumbo jet, and the aircraft can make the same maneuvers under the control of a test pilot. The test pilot feels as if he controls the model aircraft (Figure 1). It is devised so that when a danger such as overheating, etc. occurs, another safety pilot will be able to cut off the computer system and return to the usual manual control of the experimental aircraft at any time (Figure 2). The difference from a ground simulator is that the maneuvers and visual range are real, the pilot tension is high, and all matters such as wind gusts and noise are also real. That is, the difference is that experiments can be performed in actual environments. According to the April 1982 issue of AEROSPACE AMERICA, the in-flight simulator is indispensable for performing such experiments, because the ground simulator is unsuitable for carrying out the evaluation related to PIO (pilot-induced oscillation), which is a harmful oscillation induced to the control stick, etc. by pilots and for carrying out the simulation of a certain class such as the control of aircraft in the vicinity of the ground in case these aircraft land on the ground.

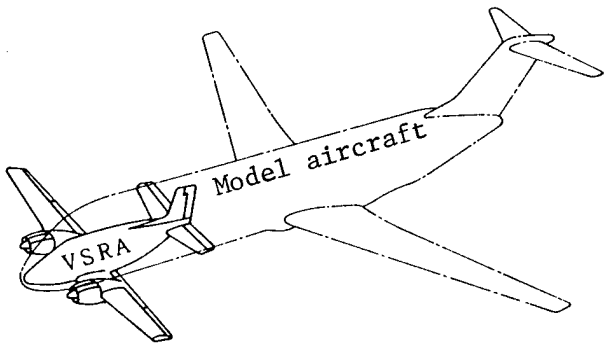

Figure 1. Simulation of Model According to VSRA

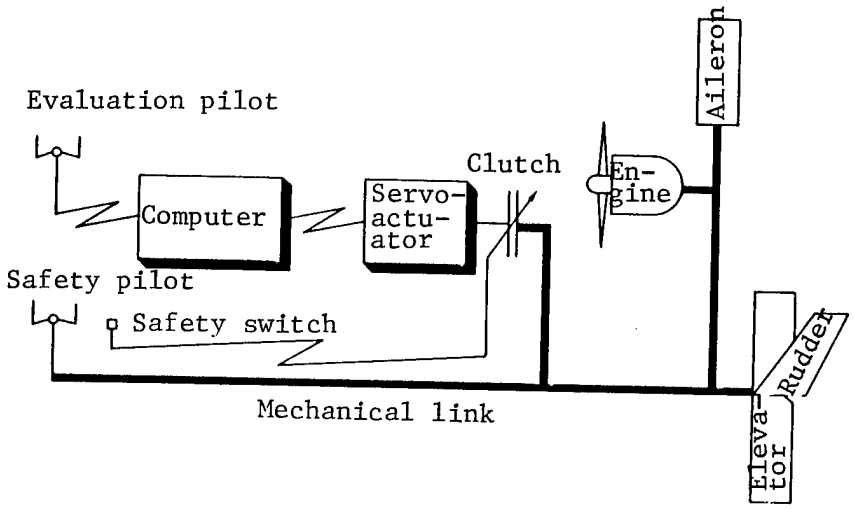

Figure 2. Outline Drawing of Control System of VSRA

NAL has performed flight tests on the VSRA for more than 160 cycles, and has conducted research on various flight systems such as flying qualities at landing, a new active-flight system called "RSS^2" independently developed by NAL, a topical rate/attitude command system, real-time gust measurement, etc. since the experimental aircraft was modified to the VSRA. It is inconvenient to change and develop programs and it has become impossible for the experimental aircraft before modification to be subjected to flight tests on various systems, because the operating section which is the main section of the aircraft before modification consists of three MPUs (microprocessor units) which carry out the parallel processing work and in which all programs are memorized only for read. Accordingly, a microcomputer with a capacity of 16 bits and 3 mips (1 million instructions per second) was introduced into this aircraft, and the aircraft was modified to the VSRA so that the three MPUs can be used as front-end calculators and the roles such as adjustment of sensor signals, output of PCM (pulse code modulation), interface between pilots and systems, etc. can be played independently. A measuring crewman operates a VSRA system through a lightweight liquid crystal terminal. Various programs were developed by using FORTRAN (formula translation) 77 so that these programs can be stored in a lightweight cartridge tape together with an OS (operating system) in accordance with the execution form and computers can be loaded on the aircraft. It was devised so that respective sensor signals and operating results can be freely and digitally recorded by giving a function of a tape recorder to the lightweight cartridge tape. As a result, the unit can be used effectively. The entire system is shown in Figure 3.

Thanks to the above modification work, it has become extremely easy to change and develop programs, the function has been sharply expanded, and it has become possible to meet new needs. It has become possible to perform various simulation flight tests on the characteristic change, complex flight system, etc. which are closer to real ones under real environments. For example, the characteristic change of a model aircraft can be seen when the model

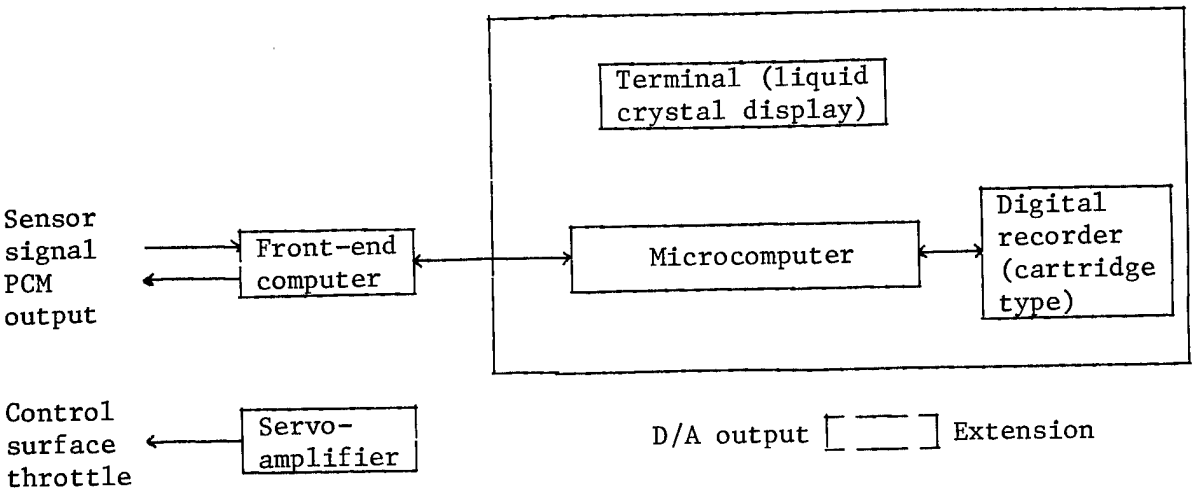

Figure 3. Functional Expansion of Operating Section of VSRA

aircraft suddenly falls into an abnormal state. Also, the complex flight system is changed depending on altitude and speed.

At present, NAL is modifying the VSRA so that the inner chord of the aircraft can possess a DLC (direct lift control) function and is scheduled to finish this modification work within the next fiscal year. After the modification work is completed, the function of the aircraft will be expanded, and it will be possible to perform flight tests on a gust-reducing system, maneuvering load control, lift redistribution, deep backside maneuver, etc.

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CSO: 4306/2553

H-II ROCKET TRANSONIC FLUCTUATION PRESSURE SIMULATION

Tokyo KOGIKEN NYUSU in Japanese Oct 86 pp 2-4

[Article by Maseo Ebihara]

[Text] NAL and NASDA (National Space Development Agency of Japan) are conducting joint research on many subjects with a view to supporting the development of the H-II rocket. One of the many subjects is a work clarification of the characteristics of transonic fluctuation pressure which acts on satellite fairing sections. Of various exciting forces which act on a rocket during flight, the exciting force generated from external airflow at a transonic speed to satellite fairing sections is extremely significant from the standpoint of the protection of satellites and the structure and strength of the rocket itself, and it seems that it is greatly profitable to obtain the characteristics of this exciting force and to establish a method of anticipating the exciting force from the standpoint of general rocket design technology as well as the H-II design technology.

NAL is scheduled to perform wind tunnel tests by using a transonic wind tunnel with a size of 2 x 2 m in order to investigate the characteristics of the exciting force, and simultaneously, NAL will carry forward a plan for establishing the method while closely correlating these wind tunnel tests with the flow numerical simulation technology whose development has been remarkable in recent years.

The difference calculus of the three-dimensional Navier-Stokes equation developed by Kohzoh Fujii, et al., engineers of the Second Aerodynamics Division of NAL, will be used as a definite method of numerical simulation. The use of the difference calculus of the Reynolds mean Navier-Stokes equation will bring about the highest simulation accuracy at the present time. In particular, a program developed by Fujii, et al. has no superiority in excellent calculation efficiency and three-dimensional flow field. A difficulty of this kind of method is that extremely high computer performance is required in this method. But fortunately, NAL is scheduled to start operating a very high-speed numerical simulator in the next spring. Environmental conditions are being arranged at this point.

A calculation example according to the use of the program developed by Fujii, et al. is shown in a photograph [omitted] and the figure shown below. The

photograph shows an isobaric graph of the flow field, and the largest advantage of the numerical simulation is that detailed drawings throughout such a flow field can be readily obtained. This example shows that the conditions of an object and those of the mainstream are in axial symmetry with each other, but the stream is not uniform in the peripheral direction. Such three-dimensionality has been observed in wind tunnel tests, and actually, it can exist. However, it has not yet been obvious whether the calculation result rightly reflects such a physical substance or is caused by some trouble in the difference calculus. The figure shows the pressure distribution on the surface of the object along the mainstream. For example, appropriate judgments concerning the location of a surface pressure sensor in wind tunnel tests can be obtained from the result of this pressure distribution. In addition, calculation results will establish many foundations for working out the contents of wind tunnel tests.

However, it is impossible to anticipate the fluctuation pressure which acts on the satellite fairing even if one uses the world top-level method developed by Fujii, et al. It can be said that direct anticipation is a problem that cannot be handled with the Reynolds mean Navier-Stokes equation after all. But if the fluctuation pressure can be expressed by combining it with the general characteristics of impulse wave intensity or separation flow, a way for coping with the direct anticipation will probably be opened even at a level of the present calculation method. Wind tunnel tests are useful for establishing this correlation and for correcting and improving the calculation method with the aim of establishing the correlation. On the other hand, the contents of the wind tunnel tests must be completed so that they can meet these purposes. For example, the vibration characteristics of the impulse wave must be obtained accurately, and the structure of the separation flow must be measured in detail. It is frequently said that it is necessary to promote both the technology of wind tunnel tests and that of numerical

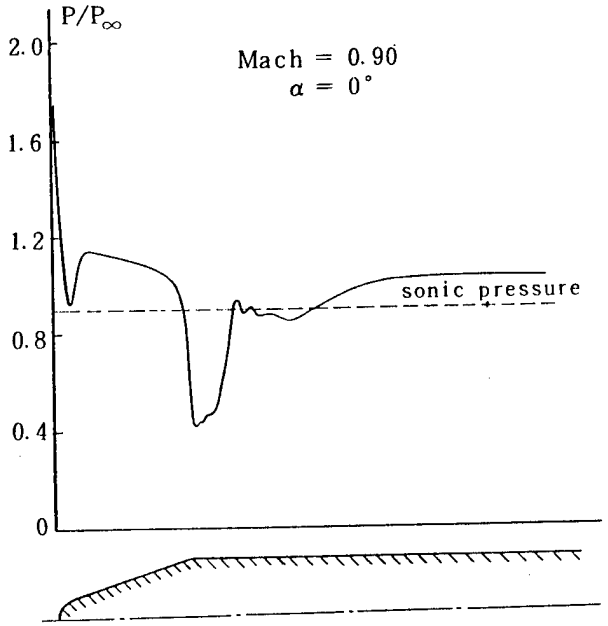

Figure. H-II Rocket Fairing Surface Pressure Distribution

simulation by organically combining these wind tunnel tests and numerical simulation, but it is not always easy to do this. NAL is planning to carry out the organic combination with consideration for the problem of the H-II rocket satellite fairing transonic fluctuation pressure.

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BASIC RESEARCH ON PULSE COMBUSTION DISCUSSED

Tokyo KOGIKEN NYUSU in Japanese Oct 86 pp 4-6

[Article by Kunihisa Eguchi]

[Text] Pulse combustion technology has a long history, and the oldest example is as follows: France tried applying this technology to gas turbines and aircraft engines in the beginning of the 20th century. Subsequently, the technology had been used mainly in aircraft in the first half of the 1900's. The V-1 rocket can be cited as a famous example. This rocket was manufactured on an experimental basis in Germany during World War II. However, the application of the pulse combustion technology to aircraft engines declined due to the advent of conventional type continuous combustors. In the 1960's, the high efficiency of the pulse combustion was reviewed, because it is better to apply the pulse combustion technology to heating burners rather than to heat sources for generating power. A household boiler employing this technology was put on the market in Canada for the first time, and products employing the technology were successively commercialized in the United States, Japan, Switzerland, etc. Recently, advantageous points such as a high load, low NOx, multiformity of fuel, etc., which are characteristics of pulse combustors, have come into the limelight, and research on the practical use of compact gas turbines employing these advantageous points is being conducted. Also, experiments on the application of these advantageous points to various combustors are being performed.

Two kinds of pulse combustors are available, i.e., the organ pipe oscillation type and Helmholtz resonance type. I will now explain the structure and operational principle of the more popular Helmholtz type. As shown in Figure 1, basically the Helmholtz resonator consists of a combustion chamber, tail tube, and unidirectional valve called a "flapper valve." When gas mixed with air and fuel introduced into the combustion chamber at the start of this resonator is ignited with an ignition plug, a kind of explosive combustion will occur in the combustion chamber, and the pressure therein will increase sharply. The pressure will discharge the combustion gas to the tail tube side at a high speed, because the pressure will close the flapper valve at the upstream side. At this time, the pressure in the combustion chamber will become negative due to the inertia of high-speed combustion gas which passes through the tail tube, the flapper valve will open, and new mixed gas will be supplied to the combustion chamber. As shown above,

the ignition and explosion are repeated. Usually, this cycle is repeated from several score of hertz to almost 200 hertz. Therefore, the Helmholtz resonator requires the ignition plug and blower only at its start, but it does not require them under steady-state conditions, and self-combustion can be maintained. This is a feature of this combustion system.

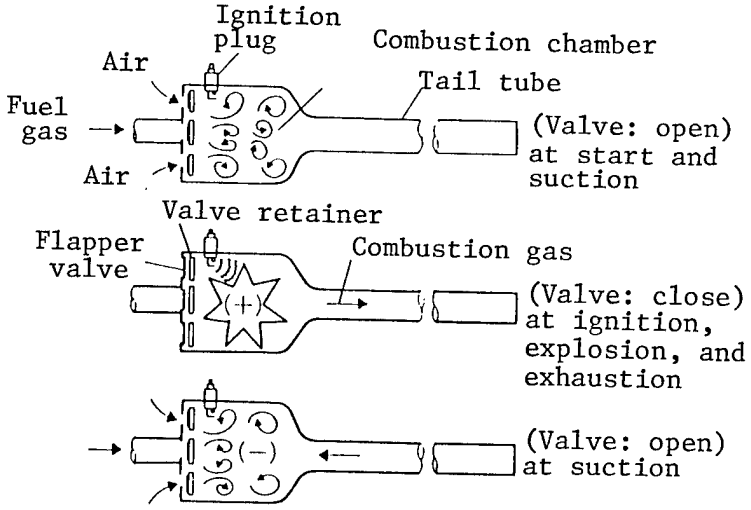

Figure 1. Operational Principle of Pulse Combustor

Compared with phenomena in conventional type continuous combustors, those in the above pulse combustor are very complex, and the combustion mechanism has not yet been clarified up to now. For this reason, at present the trial design development work has priority over any other work. Any method of effectively determining important factors for design has not yet been developed. For example, the size and shape of combustors, the method of mixing fuel and air, etc. can be cited as such important factors. Recently, basic research on the pulse combustor employing advanced laser-measuring technology has been conducted enthusiastically mainly in the United States for the purpose of breaking the above present status.

In April 1986, NAL started conducting basic research on the pulse combustor while attaching importance to the future of the pulse combustor. A combustor for research is of the twin valveless type, which can be applied to compact gas turbines. The features of this combustor are as follows: 1) an aerodynamic valve is used instead of a mechanical valve such as the flapper valve, and 2) two pulse combustors whose shape is geometrically the same as each other are arranged in a row, and acoustic interferences are generated mutually from them. The use of these features will be able to solve the problems of the durability and high noise of the valves, which have been the potential defects of pulse combustors. The purposes of this basic research are to clarify the basic combustion mechanism of the twin valveless type pulse combustor, to give effective information on the results of the clarification to the design of this combustor, and to accumulate the verification data indispensable for developing a simulation code in the future.

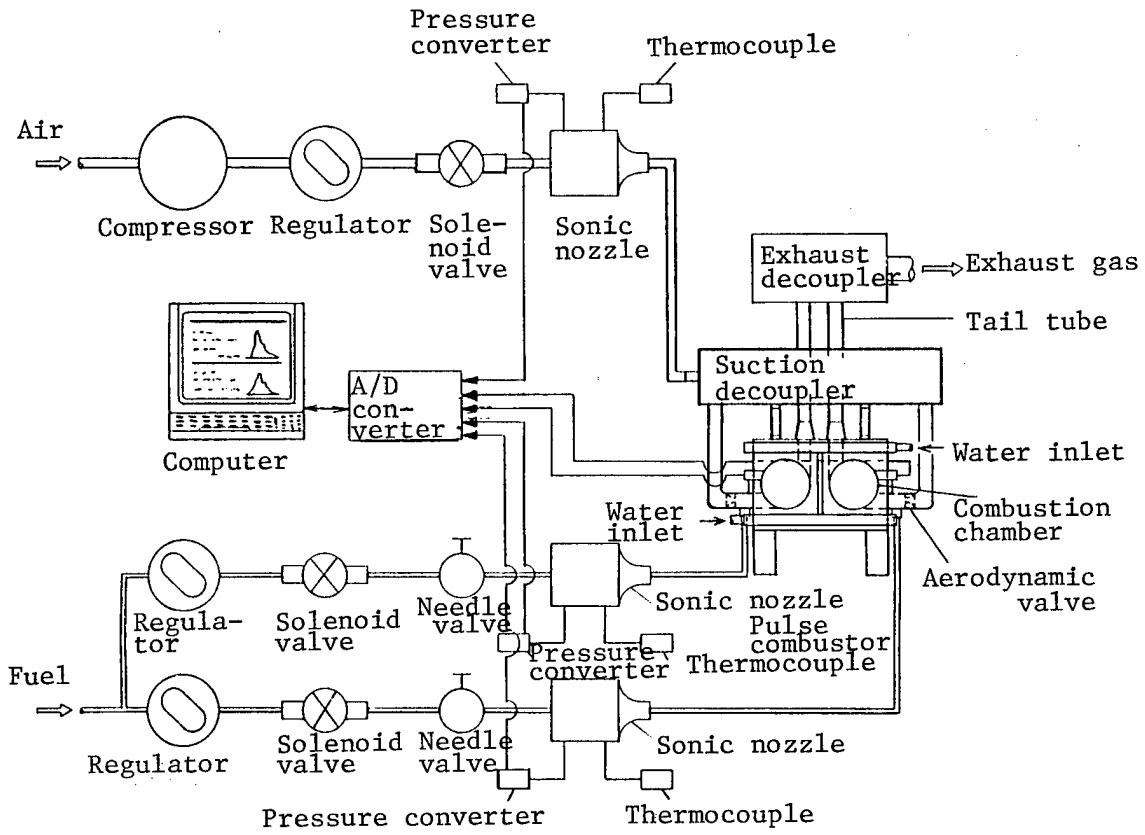

Figure 3. Structure of Experimental Unit

As the basic research progresses, NAL will measure the gas temperature according to the CARS (coherent anti-Stokes Raman spectroscopy) by using a model burner (Figure 2 [omitted]), which enables NAL to measure optically the inside of the combustion chamber; it will measure the heat-generating speed according to a chemical luminous intensity measuring method and will visualize the flow according to a laser Schlieren method. The model burner is designed so that it can have a standard thermal input of 12 kw, a calorific capacity of combustion chamber of 5.8 mW/m^3, and an oscillation frequency of 50 Hz. A quartz observation window is installed on both ends and the sides of the combustion chamber of the model burner. The change with time of local temperatures will be measured at almost real time by using a simple CARS method (refer to NAL NEWS No 326) developed by NAL. The heat-generating speed is found by measuring the chemical luminous intensity from the OH group excited in flame. The temperature and heat-generating speed are found as an ensemble average of a cycle by standardizing the pressure fluctuation in the combustion chamber, because the pulse combustion is a kind of unsteady state combustion. However, data on temperatures are sampled about once in three cycles, because the oscillation (about 20 Hz) of YAG (yttrium aluminum garnet) laser equipment for CARS cannot follow the oscillation frequency during pulse combustion.

The structure of an experimental unit is shown in Figure 3. The flow rate of air and that of fuel (methane) are measured, respectively, by using a sonic nozzle which is not readily affected by the pressure fluctuation at the downstream side. Also, all data are stored in personal computers and analyzed and processed.

Finally, this basic research is being conducted in cooperation with the Electrical Appliances Technical Research Institute of the Toshiba Corp.

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SUNLIGHT FOCUSING MIRROR FOR SPACE DESCRIBED

Tokyo KOGIKEN NYUSU in Japanese Oct 86 pp 6-7

[Article by Yoshihiro Nakamura, Space Research Group]

[Text] Japan is going to open a way for developing the field of space science and engineering experiments, material manufacturing, etc. using space environments such as nongravity, vacuum, etc. by participating in a space station project and starting a free flier project. A sunlight focusing unit is regarded as a method of efficiently obtaining a large amount of energy necessary for these space activities from a large amount of sunlight.

NAL is studying the sunlight focusing unit in expectation that this unit can be applied to useful missions such as material manufacturing, heat engine generation, etc. inspace. NAL has made experimental segments of a reflecting mirror which is a pivotal point of the unit. The shape and structure of the segments are available in two kinds, i.e., type A and type B shown in Figure 1, and both segments are regular hexagons with a maximum diagonal line of 600 mm and are concave spherical mirrors with a radius of curvature of 3,200 m. The lightness and strength as well as high-specular accuracy are required in the reflecting mirror which will be used in space, and a composite material, CFRP (carbon-fiber reinforced plastic), as a base material is suitable for this reflecting mirror. Accordingly, the type A reflecting mirror is coated with CFRP skin and has an aluminum, honeycomb structure with a view to obtaining the high-specular accuracy. On the other hand, the type B reflecting mirror is coated only with CFRP skin with a view to further reducing its weight in expectation of a shape-stabilizing effect according to the curved surface. In order to enhance the focusability of mirrors, it is necessary to minimize the surface roughness to less than 1 μm. For this reason, it has been decided that a glass-processing layer will be provided on the surface, the surface will be polished with the layer, and aluminum will be evaporated thereon. The finishing conditions of both segments are shown in Table 1. As a result of investigating the focusability by using laser beams, the light parallel to a mirror axis was focused to within 3 x 3 mm (in the case of the type A reflecting mirror) on the surface of a PDS (position-detecting sensor) located about 1,600 mm from the mirror. In addition, most of the light was within 1 mm from the center (Figure 3). In the case of the type B reflecting mirror, such light was focused to within 10 x 10 mm thereon. Also, Figure 2 shows the outline drawing of focusability-measuring experiments. If the mirrors have an ideal spherical surface, the spread of beams caused by spherical aberration is

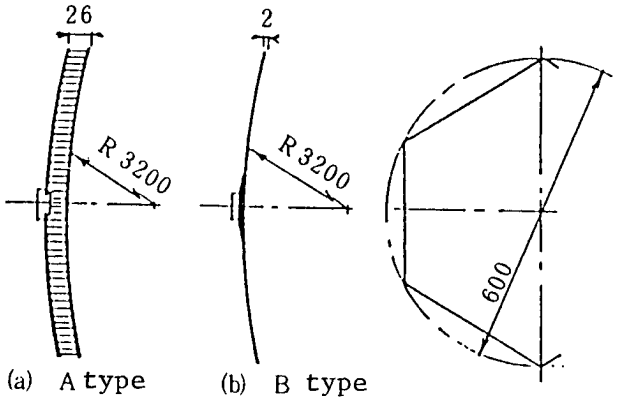

Figure 1. Shape of Trial-Manufactured Reflecting Mirrors

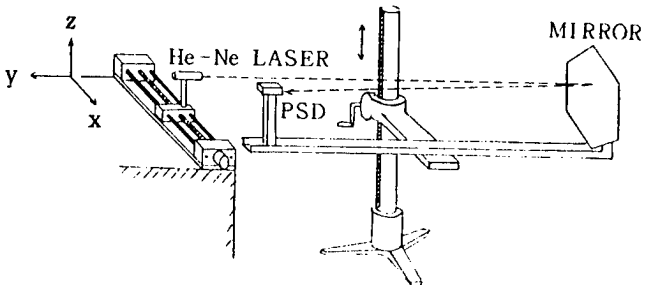

Figure 2. Outline Drawing of Focusability-Measuring Experiments

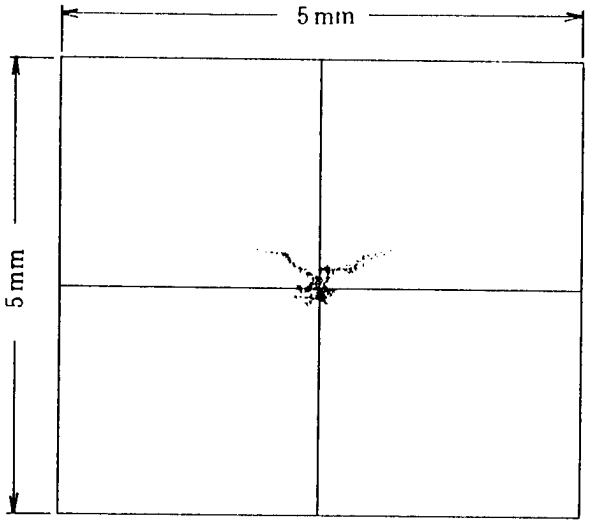

Figure 3. Example of Result of Measuring Focusability (Type A)

Table 1. Finishing of Trial-Manufactured Reflecting Mirror Segments

Segment	Type A	Type B
Weight, kg	2.60	1.30
Radius of curvature, mm	3,226.00	3,256.00
Shape error, μm (rms)	7.00	41.00
Surface roughness, μm (Rmax)	0.03	0.03
Reflectivity, percent (Wavelength, 0.5 μm)	85.5	89.5

to be less than 2 mm in the above position. Therefore, it can be said that the finishing accuracy of the type A mirror is favorable.

At the initial stage, a reflecting mirror with a diameter of about 4 m, which focuses light of about 15 kw, is suitable for the sunlight focusing unit which will be used in a space station. In addition, in order to develop this unit or to generate heat in the future, it is necessary to provide a reflecting mirror with a diameter of more than 10 m. If quasi-regular hexagonal segments close to those made on an experimental basis are arranged as shown in Figure 4, a reflecting mirror with a diameter of about 4 m will be formed. Considering the transportation to space, size of manufacturing facilities, processing accuracy, etc., it seems better individually rather than in an integrated way to form and process such a large reflecting mirror. Also, in order to obtain high focusability from a large focusing mirror, the large focusing mirror must have a parabolic surface. But it is very difficult to work such a large focusing mirror so that the mirror can have a parabolic surface. Then, when spherical segments close to each section of the parabolic surface are used instead of such a large focusing mirror with a parabolic surface, the focusability will decrease, but the requirements will be satisfied at a considerably high level.

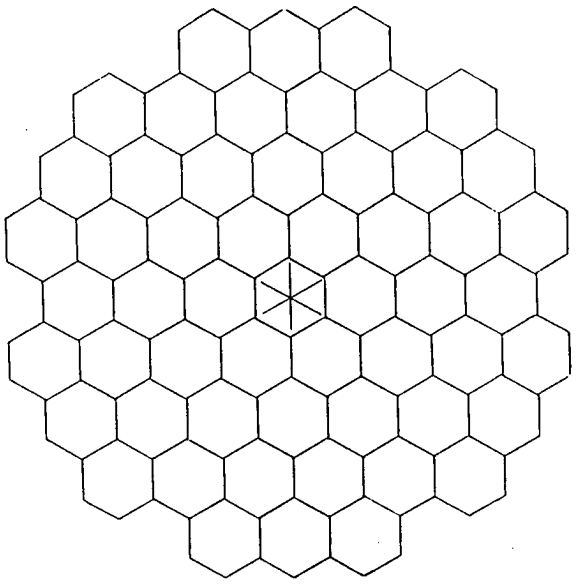

Figure 4. Plan for Dividing Reflecting Mirror With Diameter of 4 m (front view)

At present, NAL is preparing for actually focusing sunlight by using trial-manufactured segments and for heating samples by using the sunlight as a method of measuring the focusability. In the future, NAL will establish a technology for obtaining lighter reflecting mirror segments with a weight of 1 or 2 kg/m^2 while maintaining the high spherical accuracy, and it is scheduled to study the structure which can integrate these segments with a large focusing mirror with consideration for storage development.

Also, this basic research is being conducted at a science and technology promotion arranging cost.

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TOSHIBA DEVELOPS INTELLIGENT ROBOT PROTOTYPE

OW041045 Tokyo KYODO in English 1013 GMT 4 Jun 87

[Text] Tokyo, June 4 KYODO--Toshiba Corp. has developed a prototype of an intelligent robot that can solve work problems without instructions or interference from humans, a Toshiba spokesman said Thursday.

The new robot, which Toshiba says is the forerunner of the next generation of assembly robots, is able to independently assemble scattered building blocks into a fixed pattern by comparing them with a model, the spokesman said.

Toshiba's reasoning robot, which the company calls assembly robot with intelligence (ARI), resembles the upper half of the human body, having a trunk, two arms, a neck, and two cameras for viewing objects to be worked on.

Each of ARI's arms has seven joints, while its three-fingered hands have four joints each and are equipped with force sensors that operate on six axes.

The arms of the robot are controlled with two 16-bit Motorola Inc. m68000 microprocessors each. The hands, neck, and camera controllers rely on 8-bit Zilog Inc. z-80 microprocessors.

The signals from these various microprocessors are multiplexed and fed into an engineering work station, into which is also fed visual data from ARI's twin sensing cameras.

ARI solves an assembly problem by using artificial intelligence to analyze a scene of a real world model, and estimate its structure. It then creates a program to recreate the model and carries it out.

In comparison, most of the robots currently installed in factories have no sensing or inference capabilities, and hence are limited to performing repetitive tasks.

/8309
CSO: 4307/6072

STATUS OF R&D ON EXTRACTION OF URANIUM FROM SEAWATER

Tokyo GENSHIRYOKU GAKKAISHI in Japanese Jun 86 pp 23-29

[Article by Masayoshi Kano and Yoshi Ogawa]

[Text] [Summary in English] The Special Committee of Extraction of Uranium from Seawater had worked on the technical survey of the up-to-date situation of this technique as well as the exchange of the relevant information among its members during 1981-1985. This committee had organized the International Meeting on Recovery of Uranium From Seawater on October 1983 in Tokyo with auspices of the IAEA. This is a report of its activities covering the present status of the research in this field since then. [End summary]

1. Preface

Research and development [R&D] on the extraction of uranium from seawater shows a worldwide trend toward curtailment due to the delay in world industrial development, energy conservation, and the resultant fall in oil and uranium prices. However, the necessity for R&D on the extraction of uranium from seawater to secure uranium resources for a country like Japan, whose industrialization is indispensable and whose energy resources are not abundant, never diminishes from the long-term viewpoint.

The Metal Mining Agency of Japan was commissioned to carry out this research program under the Agency of Natural Resources and Energy, Ministry of International Trade and Industry [MITI]. As part of this program the construction ofa model plant capable of producing 10 kg of uranium annually was started 4 years ago at Nio Town, Kagawa Prefecture, and completed in March 1986. Preparation and design were conducted by the Tokuyama Soda Co., Asahi Chemical Industry Co., Mitsubishi Metal Corp., and Taisei Corp. As for research in universities, basic research on the extraction of uranium from seawater was carried out at Kumamoto University, Miyazaki Medical College, Hiroshima University, Kyoto University, and Tokyo University as part of the special research program on energy, and subsidized by the Education Ministry's scientific research funds starting in 1981. This program is expected to continue for several more years. In addition, research on the extraction of uranium from seawater has continued at the Industrial Technology Laboratory of Shikoku, Science and Technology Agency. Thus, Japan can be said to be most active worldwide in this research area.

Special Committee on Extraction of Uranium From Seawater
(October 1983-September 1985) (Names without titles and no special order is observed)

Chairman:
Masayoshi Kanno (Nagaoka College of Technology and Science)

Secretaries:
Yoshi Ogawa (Taisei Corp.)
Michio Yamawaki (Tokyo University)
Koichi Yoshihara (Mitsubishi Metal Corp.)
Yasuo Kaminami (Mitsubishi Chemical Industries, Ltd.)
Kyoichi Saito (Tokyo University)
Keiji Ashida (Ebara Industry)

Members:
Shoichiro Hayashi (formerly with the Power Reactor and Nuclear Fuel Development Corp.)
Kazuhiko Kanba (Shikoku Industrial Technology Laboratory
Seichi Morisawa (Nagaoka Wire Cloth)
Kanji Otaguro (Mitsui Petrochemical Industries, Ltd.)
Jiro Okamoto (Japan Atomic Energy Research Institute)
Shinji Takai (Production Technology Research Institute, Tokyo University)
Noboru Ogata (Japan Tobacco Industry)
Yu Kubota (Mitsui Engineering and Shipbuilding Co., Ltd.)
Nagayasu Taniguchi (Metal Mining Agency of Japan)
Yoshiaki Echigo (UNITIKA, Ltd.)
Motoyuki Suzuki (Production Technology Research Institute, Tokyo University)
Tsuneo Hata (Ebara Corp.)
Kunihisa Aburaya (Tokuyama Soda Co., Ltd.)
Junichi Miyazaki (Tokuyama Soda Co., Ltd.)
Seiji Orii (Nippon Soda Co., Ltd.)
Tadao Yamada (Mitsui Toatsu Chemicals, Inc.)
Kazuto Okamoto (Tokyo University of Arts and Sciences)
Bunpei Ishii (MAPI)
Seigo Ono (Toshiba Corp.)
Tsuneo Hiratsuka (Metal Mining Agency of Japan)
Iwao Tabuse (Kyoto University)
Saburo Seno (Shinshu University)
Yoichi Takamiya (Asahi Chemical Industry Co., Ltd.)
Teruki Nishikawa (Ishikawajima-Harima Heavy Industries Co., Ltd.)
Chie Miyake (Osaka University)
Saburo Murakami (Tokyo Electric Power Co., Inc.)
Ichiro Inomata (Tokyo Electric Power Co., Inc.)
Katsumi Nagatoshi (Sanko Metal Industrial Co., Ltd.)

This committee was originally set up as a technical research committee in October 1977 and two reports, Nos 1 and 2, were published in the first 4 years. The committee began its activities as a special committee in 1981 and 2 years later held an International Meeting on Recovery of Uranium From

Seawater (IMRUS-1983) (Report No 3) during the period from 17 to 19 October 1983 under the joint auspices of IAEA in Tokyo. The purpose was to make an overall review of the results of research so far achieved. The committee is still active at present, but since 2 years have elapsed since IMRUS-1983, the report is based on the results of research so far achieved.

2. Granular Adsorbents

There are several methods of extracting uranium from seawater, such as coprecipitation, adsorption, flotation, and solvent extraction, but the adsorption method using adsorbents, which is regarded as having the brightest prospects, has mainly been employed up to now in the research in this area. In a study of a wide variety of adsorbents for this use, the hydrous titanium oxide of an inorganic system and amidoxime-type chelate resin of an organic system have been found promising for practical use.

2.1 Hydrous Titanium Oxide

In the Metal Mining Agency of Japan project, granular adsorbents made of hydrous titanium oxide and those based on it are mainly being studied.

In its early stages, the method for granulating hydrous titanium oxide was to press the oxide without using any binder and to crack it. The tests of adsorption and desorption were conducted repeatedly by using a fixed bed, with the results as shown in Figure 1.

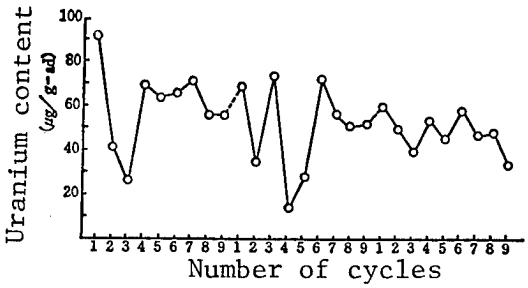

Figure 1. Amount of Uranium Contained in Adsorbent After Adsorption

However, troubles such as clogging, etc., occurred in the adsorption bed so that adsorption by using a fluidized bed was considered superior. It was further found that the press-forming method cannot ensure sufficient mechanical strength and withstand long-term use.

On the assumption that a porous adsorbent can adsorb more uranium, a method to press-form hydrous titanium oxide added to sodium chloride, calcium sulphate, etc., and to elute it, after cracking, with water and diluted hydrochloride acid was examined. By this method the quantity of uranium adsorbed per unit of weight increased 1.8 times, but the mechanical strength dropped.

Thus, the screw-extrusion granulating method and condensation granulating method, both using an organic binder, were studied and consequently a high-quality granular adsorbent was developed, which is capable of adsorbing a great quantity of uranium, withstanding long fluidized bed tests and resisting abrasion. The results of continuous tests of an adsorption and desorption cycle on the fluidized bed, with hydrous titanium oxide which was granulated through condensation with an organic binder, are shown in Figure 2. Other than the seventh and eighth cycles, adsorption was conducted for 10 days and desorption was conducted with hydrochloride acid. No deterioration of the adsorbent was observed, as shown in Figure 2.

At a meeting of this committee a report was presented on hydrous titanium oxide from the viewpoint of the titanium oxide industry. While the world's production capacity of titanium oxide is about 2.55 million tons a year, that of Japan stands at about 230,000 tons. At present, Japan is importing about 500,000 tons of titanium annually in the form of ilmenite slag, rutile, etc., but there is at present no disquieting sign about its stable supply.

2.2 Amidoxime-Type Chelate Resin

Aiming at the developing of an adsorbent with a higher uranium adsorption speed, the research designed for improvement of amidoxime-type chelate resin (AO-resin) is being conducted through the joint effort of the Shikoku Industrial Technology Laboratory, Production Technology Research Institute, Tokyo University, and Mitsubishi Chemical Industries.

The initial I-type AO-resin adopts divinylbenzene (DVB) as a bridging agent. II-type resin uses tetraethylene glycol dimethacrylate (TEGDM), a hydrophile bridging agent, and this agent, it was found, largely increases its uranium adsorption speed. The hydrophilicity of the parent resin has a great effect on the adsorption speed. This indicates that the diffusion of the uranyl ion contained in the parent resin is a process of regulating the uranium adsorption speed. The improvement of the parent resin itself can provide a higher uranium adsorption speed.

Although the II-type resin increased its uranium adsorption speed, it showed a great change in volume at the time of adsorption and desorption. III-type resin uses a mixture of TEGDM and DVB, and IV-type resin is compounded at the fittest ratio with these substances. Furthermore, the V-type resin, the resin which controls a microporous structure and has a large number of mesopores that concern the adsorption of uranium, is now under study. As a result, the adsorption speed per volume has largely been improved. The physical properties of I-type to IV-type resins are shown in Table 1 and the results of adsorption tests conducted at the seawater temperature of 25°C and the linear velocity of the flow of LV20 cm/min, which uses adsorbent of 5 g are shown in Figure 3. As shown in Figure 3, the adsorption speed has been substantially improved. Likewise, repeated adsorption and desorption tests of the AO-resin are being carried out. Although the adsorption ability did not drop until the 10th round, the functional group was recognized to be unstable against acid; thus development efforts are being made to improve it.

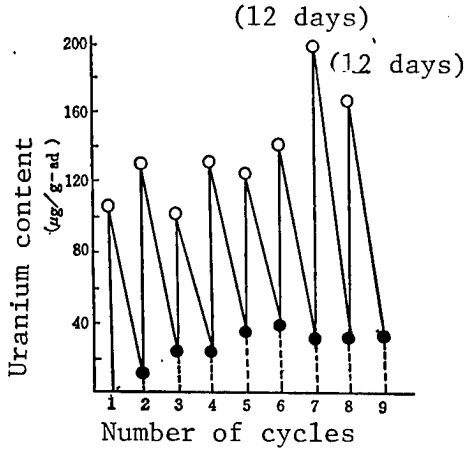

Figure 2. Uranium Content, Before and After Desorption of Each Cycle on Fluidized Bed, of Adsorbent Granulated With Organic Binder

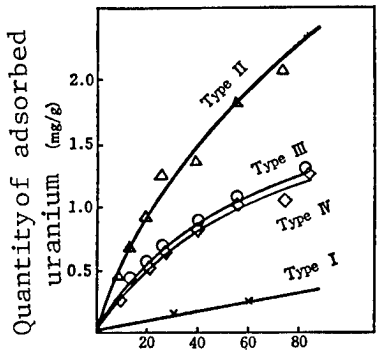

Figure 3. Uranium Adsorption Speed From Seawater

Table 1. Properties of Microporous-Type AO-Resin

	Adsorbents			
Bridging agents	DVB	TEGDM	TEGDM-DVB	TEGDM-DVB
Specific surface area (m^2/g)	72	39	56	84
Volume of micropore (mℓg)	0.63	1.52	0.89	0.84
Average micropore diameter (Å)	200	1,000	350	300
Density of moist resin (g/mℓ)	--	1.09	1.11	1.13
Copper (Cu^{2+}) adsorption capacity				
(mmol/g)	1.17	2.08	2.41	2.55
(mmol/mℓ)	0.34	0.53	0.74	0.81
Volume change				
Desalinated water	1	1	1	1
4 percent saline solution	--	0.86	0.95	1.00
1nNaOH water solution	1.02	8.00	2.85	1.12
1nHCl water solution	1.04	4.40	2.20	1.13
Average particle diameter (mm)	0.53	0.61	0.48	0.58
Remarks	Basic-type resin			
Hydrophile improved-type resin, highly expansible and moist				
Expansibility-moistness improved-type resin, low expansibility and moistness				
Intensity improved-type resin				

DVB: dyvinylbenzene; TEGDM: tetraethylene glycol dimethacrylate

2.3 Phosphoric Acid-Type Resin

Other than the above, information was given at IMRUS-1983 on a dihydroxy acid-type chelate resin and a composite resin containing ethylenimine and maleic acid anhydride. At a meeting of this committee a report was also made on the phosphonic acid-type resin. The phosphonic acid-type resin (RCSP), which was obtained through hydrolizing by having it react on phosphorous trichloride after chloromethylating an MR-type globular polymer of stylene-DVB, adsorbs uranium from seawater excellently. The results of feeding seawater by means of an upward current by using the RCSP showed a low value of 30 mg/ℓ-resin/10 days, compared with the 100 mg/ℓ-resin/10 days of an MR-type chelate resin having the amidoxime radical, which was synthesized by using $10^{mol}/0$ of DVB. However, the RCSP was very stable even in a strong acidic solution and no decline due to reuse was recognized in its adsorption efficiency at all.

As mentioned above, the development of granular adsorbents is progressing because of the importance of their long durability as opposed to their adsorption with a fluidized bed and their cycles of adsorption and desorption. It is hoped that test data will be accumulated over a long period of time. (Junichi Miyazaki, Tokuyama Soda Co., Ltd.)

3. Fibrous Adsorbents

Fibrous adsorbents have the advantage that they can take any form other than a fibrous one such as cloth and spherical shapes according to contacting systems with seawater. As a fibrous adsorbent, an amidoxime-type fiber has mainly been developed. Amidoxime-type fibers can be classified into the following three kinds by its synthesizing method:

(1) Fiber using an acrylic fiber as a primary raw material.

(2) Fiber using an acrylonitrile graft fiber as a primary raw material.

(3) Fiber which is made fibrous by conjugating a fine granular amidoxime resin with other resins.

3.1 Fiber Using Acrylic Fiber as Primary Raw Material

A nitril radical was developed into amidoxime by having an acrylic fiber procured from the market react on hydroxylamine in a methanol solution for a certain period. The longer the development of amidoxime takes, the more the radical weight of the amidoxime increases and the more the uranium adsorption speed accelerates. If an alkali treatment is given to it in InNaOH, the acidic radical weight, the carboxyl radical weight in particular, increases and the uranium adsorption speed accelerates markedly. The intensity of the filament decreases just as the acidic radical weight increases. However, the intensity of the filament can be improved by means of crosslinking treatment or by using an acrylic fiber of high intensity.

A spherical amidoxime fiber with a diameter of 3-4 mm was prepared by developing an acrylic fiber of a certain length into amidoxime by agitating it in a methanol solvent. By soaking a column filled with it in filtered seawater,

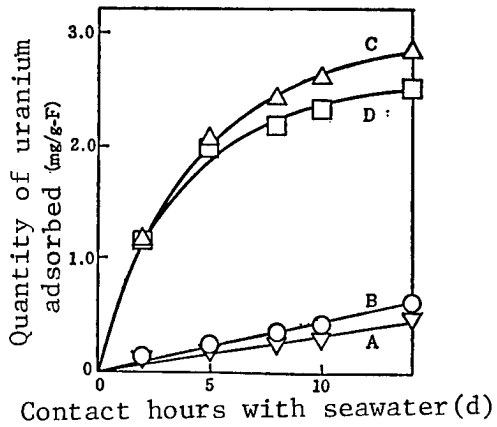

Figure 4. Uranium Adsorption Speed of Globular AO-Fiber
Particle diameter (mm) A:20; B:10; C:3; D:5

the change on standing of the amount of uranium adsorbed was examined, the results of which are shown in Figure 4. The center and the exterior of the globe show no difference in the amount of uranium adsorbed.

Experiments were also carried out by dipping in a parallel flow of seawater a piece of amidoxime fiber cloth prepared from acrylic cloth available from the market.

3.2 Fiber Using Acrylonitrile Graft Fiber as Primary Raw Material

An amidoxime fiber was synthesized by developing amidoxime through the grafting of acrylonitrile by irradiating a tetrafluoroethylene-ethylene copolymerized fiber. The distribution of the amidoxime radical inside the fiber can be controlled by having acrylonitrile react on either a gas or a liquid. In the case of the gas the amidoxime radical ranges as far as 10 μm from the fiber surface and in the case of the liquid it spreads evenly over the entire fiber. The grafting of a small quantity of acrylic acid together with acrylonitrile provides hydrophilicity and thus uranium adsorption improves.

The curve of adsorption speed of the amidoxim-type fiber (a 40-μm diameter) synthesized through the radiation-induced graft polymerization by using polypropylene as a basic material is shown in Figure 5.

By making the most of the radiation-induced graft polymerization that allows a free choice of basic materials, an amidoxime resin has been synthesized with a porous polyethylene film and (holofiber) basic materials.

3.3 Fiber-Conjugating Fine Granular Amidoxime Resin

The use of a composite adsorbent conjugating a fine granular amidoxime resin with polyethylene and silica obtained an adsorption speed curve, as shown in Figure 6. Since an adsorption system utilizing an ocean current is assumed, experiments are being conducted by changing the drift of a current. (Kyoichi Saito, Technical Department, Tokyo University)

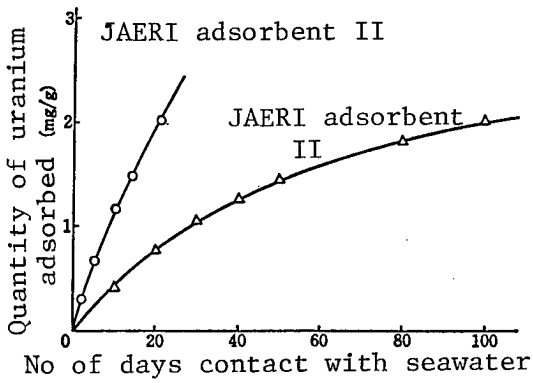

Figure 5. Adsorption Speed of Amidoxime Fibers Synthesized by Radiation-Induced Graft Polymerization
Note: JAERI--Japan Atomic Energy Research Institute

4. Desorption and Enrichment

The processes that occur after the adsorption of uranium from seawater by adsorbents are desorption, the recovery of adsorbents, enrichment, and refining.

Desorption methods are roughly classified by adsorbents into 1) an ammonium carbonate method; 2) a sodium carbonate method; and 3) a mineral acid method. However, the ammonium carbonate method is omitted because of the difficulty of preventing the contamination of the sea by ammonium, in addition to the high recovery expenses of adsorbents. The sodium carbonate method has no such disadvantage, but its adsorption speed is slow and the uranium recovery rate is somewhat low.

Since the problems that the alkaline adsorbents create became apparent, and at the same time a granulated titanium oxide adsorbent with superior oxidation resistance was developed, a new look was taken at the acid desorption method using mineral acids. As a result, the model plant at Nio Town adopted the acid method. Of mineral acids, hydrochloride acid and sulfuric acid can be the objects of consideration, but the use of sulfuric acid is not feasible because of the obstruction of desorption by the precipitated calcium sulphate. Thus, there is no alternative but to use hydrochloride acid, though it costs more. Even desorption with hydrochloride acid has disadvantages in that acid consumption is great due to calcium and magnesium, and enrichment, which will be referred to later, will become difficult. Thus, it remains a question awaiting a solution.

The desorption process should be designed in accordance with the kind of adsorbent. That is, an adsorbent has a form such as granular, flat-plate, powdery, or fibrous, according to which desorption devices differ. The acid desorption process is comprised in detail of the transferrence of an adsorbent, cleansing in diluted acid, precleansing, desorption, postcleansing, the recovery of a desorbent, and the recycling and reactivation of an adsorbent. At present, a pumping system is employed for transferring adsorbents. The cleansing in diluted acid uses a hydrochloric acid of 1 BET volume, and

pre- and post-cleansing uses industrial water of 1-2 BET volume. The diffusion dialysis method is considered feasible for recovering desorbents. For desorption, the main process, a one-process, one-stage system or one-process, three-stage system, as examined as a method to bring a desorption liquid into contact with an adsorbent and efforts are being made to send the desorption liquid containing uranium with as high a concentration as possible to the enrichment process.

Enrichment largely depends on desorption methods. It is necessary to choose a proper enrichment (extraction and separation) system according to the kind and concentration of desorbents or to the degree of recovery of the desorbent after the completion of desorption. Concerning alkaline desorption liquids, the ion exchange method, flotation method, and sedimentation method can be considered. Under the ion exchange method, if the concentration of an alkaline agent is reduced below the level of 0.3M by recovering all the desorbent after the completion of desorption, it is possible to enrich uranium with an ordinary anion exchange (resin) to the concentration of 5-10 g/ℓ at nearly a 100 percent recovery rate.

With respect to the flotation method, various systems are being examined such as ion flotation, sedimentation flotation, and adsorption particle flotation. The ion flotation method is to float uranium together with air bubbles and separate it by using a surface-active agent, which forms a hydrophobic deposit by developing a selective chemical reaction on a uranium ion. This method has the advantage that it provides a very high uranium enrichment factor and allows us to process a large amount of desorption liquid continuously and speedily with a compact device. However, problems remain that the range of pH, in which the surface-active agent reacts on the uranium ion effectively, is limited and the pH regulator can cost more depending on the properties of the desorption liquid. The sedimentation flotation and adsorption particle flotation methods, and the simple coprecipitation method, which does not adopt flotation, are presently omitted from examination. The reason is that despite their satisfactory uranium recovery rates, their enrichment factors are low because colloidal sediments with a high percentage of moisture content are used as a medium, which is difficult to separate after the completion of recovery.

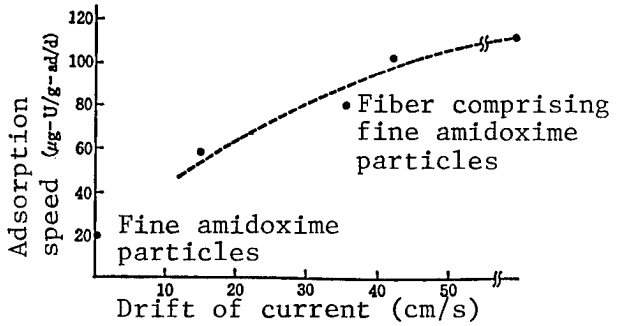

Figure 6. Adsorption Speed of Fiber Comprising Fine Granular Amidoxime Resin

On the other hand, concerning acid desorption liquids, the ion exchange and solvent extraction methods are being examined. In the application of the ion exchange method to a hydrochloric acid desorption liquid of a low hydrochloric acid concentration, the ordinary anion or cation exchange resins scarcely adsorb uranium and a special chelate resin is required, so this application is uneconomical. It also poses a problem that even the use of the chelate resin does not provide a greater enrichment factor due to a small adsorption quantity, obstructed strongly by other heavy metals and organic matter contained in the acid desorption liquid.

There is the solvent extraction method in place of the ion exchange method. The solvent extraction method, which is widely employed in uranium mines, is an excellent system for extracting and enriching uranium from acid solutions, but the limit of the economically applicable concentration of uranium is considered to be about 100 ppm. With the concentration (20-50 ppm) of the desorption liquids presently in use, this method is economically difficult to apply. Since the necessary number of extracting stages is too many, the device becomes larger and the loss of solvents increases. At any rate, if the hydrochloric acid method is eventually adopted as a desorption method, it is necessary to choose the most adequate enrichment system accordingly. With respect to the ion exchange method, the development of a new resin capable of adsorbing uranium without interference by impurities is necessary. As for the solvent extraction method, it is necessary to develop an inexpensive extraction method through a thoroughgoing examination from an engineering viewpoint and, on completion of the development, make a comparative study of the economic efficiency of both methods. (Koichi Yoshihara, Mitsubishi Metal Corp.)

5. Adsorbents, Seawater Contacting Systems, and Cost Estimation

As a contacting system, the wave force utilization system and the iceberg utilization system were introduced in detail and cost estimation was just conducted on an ocean current utilization system and a pump fluidization-type fluidized-bed system.

The concept of wave force utilization-type seawater uranium extraction was introduced in the following three systems: 1) the reservoir system devised by VBB-SWECO of Sweden; 2) the net system devised by Masuda of the Oceanic Science and Technology Center; and 3) the column system which installs a column similar to that used directly under the existing pump fluidization system in the sea. Although sea waves have the shortcoming of irregularity, they have an attractive point in that the annual average of wave energy at the coastal areas of Japan is as large as 10-13 kw/m and their energy cost is nothing. Masuda, Hotta, and their team from the Oceanic Science and Technology Center conducted experiments in uranium adsorption by installing on buoys columns filled with amidoxime resins, as shown in Figure 7, off the coast of Tsuruoka City, Yamagata Prefecture. As a result, a column was found indicating a maximum adsorption speed of approximately 80 μg-U/g-R•10 days. The effects of adhesive organisms and the enlargement of the device are presently under study.

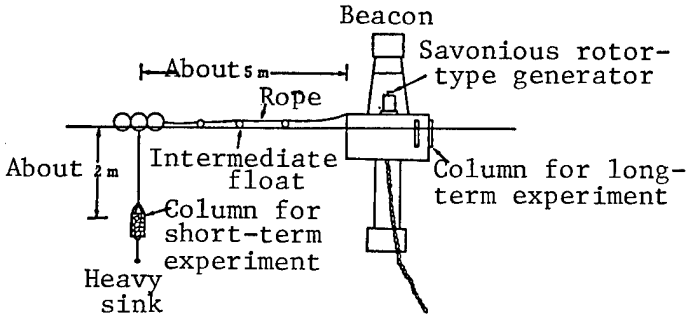

Figure 7. Column-Type Uranium Recovery System Utilizing Wave Force

The idea of the iceberg drift method, which was proposed by Nishiyama of Kyoto University, is to recover uranium on an iceberg, around which ropes with a number of buckets containing adsorbents are stretched and turned around slowly. In one model, a 500-m wide iceberg drifting at the speed of 1-2 knots is assumed. As shown in Figure 8, five parallel ropes, each 5 km long, holding containers, are hung parallel on the iceberg 3 m apart. Two sets of these ropes are assumed to be installed on each iceberg and are estimated to cost less than other systems; the construction cost for the extraction capacity of 200t/U/yr is ¥3 billion and operating expenses are ¥165-75 million. With regard to the ocean current utilization method, the cost of the fixed-bed type device using a floating body was estimated by Okazaki of Kyoto University. On the assumption that amidoxime resin particles are chosen and a fixed bed is installed in seawater, breakthrough curves under various conditions were drawn and uranium-extraction expenses were estimated at about ¥200,000/kg-U per 1,000t-U/yr capacity by seeking the relationship between the amount of adsorption and the number of days spent for adsorption. The use of hydrous titanium oxide particles is estimated to double its cost.

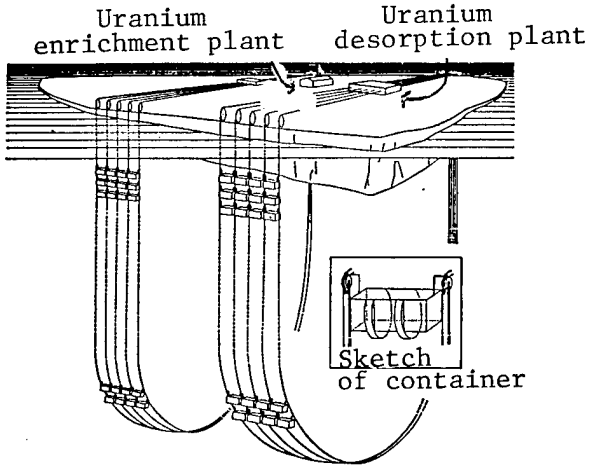

Figure 8. Uranium Recovery System Using Iceberg

Likewise, the cost of a pump fluidization-type fluidized-bed system with an assumed 1,000t-U/yr capacity was estimated by Suzuki of the Production Technology Research Institute of Tokyo University and Chihara of Meiji University. It was then assumed that the fluidized bed is filled with hydrous titanium oxide particles with a diameter of 0.1 mm, that the adsorption section is conveyed by the slurry transportation system, that ammonium carbonate is used as a desorbent, that a stripping method is adopted for recovering the desorbent, and that a strong base anion exchange resin is used for secondary enrichment. Determining the material balance of each ingredient with regard to the entire process by calculating with a signal-line diagram, the capacity of each device and the operating expenses were estimated by a chemical engineering calculation method. As a result, a minimum cost of ¥160,000/kg-U was obtained. The adsorption cost represented 80-90 percent of the total cost, which is shared equally by fixed and variable expenses. The expenses on electric power for the pump represented a great part of the variable expenses.

Likewise, the cost of the pump fluidization-type fluidized-bed system was estimated by Ogata of the Japan Tobacco Industry. His estimate is distinctive, since it was made on a multilayer system, and a sensitivity analysis was conducted of the properties of adsorbents, operating conditions, and unit prices of materials. In the case of a four-layer structure with the capacity of 100t-U/yr, when using the hydrous titanium oxide adsorbent, it is estimated at $160/lb-U308 (equivalent to about ¥93,000/kg-U); when using the amidoxime resin adsorbent, it is estimated at $280/lb-U308 (equivalent to about ¥162,000/kg-U), but the former will decline to the level of $67/lb (about ¥47,000/kg-U) depending on future technological improvements.

Recent reports on the evaluation of systems and estimates of expenses were outlined as above. Although they include unconfirmed values and assumptions, these values are the approximate figures that can be obtained at this moment. As technological development advances, more accurate system evaluations and cost estimates may be possible (an exchange rate of ¥220 fo $1.00 was applied). (Michio Yamawaki, Technical Department of Tokyo University)

6. Ocean Structures and Large-Capacity Pumps

6.1 Ocean Structures

Since facilities for recovering uranium from seawater handle a great amount of seawater, they inevitably become an unprecedentedly gigantic ocean structure.

The siting of structures at sea is presently being stepped up to meet the need to utilize energy, sites, and space. The diversification of the siting and operating conditions of such facilities is characteristic and a number of structural forms and construction methods are being devised according to these conditions. In the North Sea, for example, in order to develop oil energy, a new technology is being developed capable of standing severe conditions in which there are only 40 calm days a year, the depth of the sea is 200 m and a wave height is 30 m.

Ocean structures are classified by structural form into: 1) leg type; 2) sinking type; and 3) floating type. The leg-type structure is fixed on the seabed with steel pipe piles, and the sinking-type structure is sunk to the seabed only by the weight of concrete used in the structure and so on. The floating-type structure takes the form of a ship or a barge and is moored with an anchor and chains. The floating-type structure becomes economical as the depth of the seawater increases.

The ocean structures can also be classified by application as follows: 1) an oil platform (North Sea oil well, etc.); 2) a bridge across the sea (the bridge connecting Shikoku Island and the Honshu mainland, etc.); 3) an undersea tunnel (the metropolitan speedway coastal tunnel, etc.); 4) a port structure (a breakwater, etc.); 5) a manmade island (Kansai's new airport, etc.); 6) cargo-handling facilities (sea berth, etc.); 7) water intake and discharge facilities (electric power plant, etc.); 8) a floating plant (the sewage disposal plant in Atami, etc.); and 9) a closing levee (the Delta plan, etc.).

The proposed facilities for recovering uranium from seawater are designed after the pattern of these ocean structures, and roughly divided into the coastal type (sinking type and platform type) and the floating type. The sinking type includes the pumping-up system of the U.S. Department of Energy and the pump column system of the Metal Mining Agency of Japan. The U.S. MIT system is proposed as the platform type. The floating type includes the wave power utilization floating-body system of Sweden, the loop system seawater uranium adsorption ship of West Germany, and the seawater uranium adsorption ship using the wave power energy of the Oceanic Science and Technology Center. In addition, seawater uranium recovery facilities combined, respectively, with plants for electric power generation by temperature difference, wave power generation, ocean current power generation, and offshore power generation, all of which falls on the same ocean utilization area, are being proposed.

When designing facilities for recovering uranium from seawater, which are expected to become a huge ocean structure, it is necessary to work out a total system that is economical and is efficient in getting thoroughly familiarized with the present condition in which most ocean structures are being utilized.

6.2 Large-Capacity Pumps

The amount of seawater required for recovering 1,000 tons of uranium a year is about 10,000 m^3/s, with an adsorptivity of 100 percent. In order to bring a great amount of seawater efficiently into contact with adsorbents by the pump system, it is necessary to develop a pump with a capacity of pumping several hundred cubic meters per second.

Large-capacity pumps have already been developed in Japan for the purpose of discharging water into the sea or other rivers to lower the water level of a river in case of a potential flood or of constantly discharging river water to prevent land subsidence.

At the Shinkawa River in Niigata Prefecture, six units of an X-axis axial-flow pump with a capacity of 40t/s have been installed. The speed of one of these pumps is as slow as 60 rpm and its head is low, but its pumping efficiency is high. Ordinate-axis axial-flow pumps (the blade diameter is 4.3 m and capacity is 5.3 m^3/s) capable of making the head higher than that of the X-axis pump have also been developed. Furthermore, a clinoaxis-type pump designed to reduce duct loss and a pump called a tubular pump with a driving gear inside the cylindrical case have also been developed.

When handling a great amount of seawater for recovering uranium, it is necessary to raise the N_s, specific speed, as shown in the following formula, to the level of 3,500:

$$N_s = N_r \sqrt{Q/H}$$

where: N_r: represents rotation frequency (rpm)
Q: represents quantity
H: represents head

The present practical specific speed is 2,000-2,240, but it is necessary to solve the following problems in order to develop a pump with the specific speed of 3,000-4,000 level:

(1) the development of reduction gear;
(2) the design to have a civil engineering structure bear a thrust load;
(3) the problem of a lubricating film caused by ultra-low speed (20-30 rpm);
(4) the selection of economical materials.

(Yoshi Ogawa, Taisei Corp.)

7. Conclusion

Of the achievements in the R&D on the extraction of uranium from seawater, the development of adsorbents has made rapid strides in recent years. As for the adsorbents of the hydrous titanium oxide system, which has been under study from the earliest days, the use of them on a fluidized bed or their transfer to the desorption process by the slurry transportation system were far from consideration until today because of their inadequate mechanical strength. However, recent progress in the granulating method has provided sufficient mechanical strength to withstand these processes. With respect to desorption with acid, because of the inadequate chemical stability of adsorbents their elution due to desorption liquids was unavoidable until recently. However, it is now possible to keep it to a minimum.

A certain degree of knowledge was acquired about the overall uranium recovery system that includes adsorption, cleansing, desorption, the recovery of desorption liquids and the reenrichment of uranium, and the reuse of adsorbents is being corroborated to some extent. These things will be proved further as the model plant in Nio Town, Kagawa Prefecture, begins operating on completion. With research activities centered on the universities, organic adsorbents of the amidoxime system and dithio carbamate system, and new

adsorbents originating from biotic bodies such as tannin, are being developed one after another, so further progress is expected to be made in their research activities.

However, research on the contacting system of seawater and adsorbents, which controls the cost of extracting uranium from seawater, the design of the entire plant system using it, and the estimated cost of uranium recovered by this system, is making little progress, because it is difficult to evaluate scientifically. Therefore, further studies are desired on a contacting method and a plant system that is designed to reduce the cost of extracting uranium from seawater.

20110/9365
CSO: 4306/2530

FY87 'BIG PROJECT' R&D BUDGET OUTLINED

Tokyo JITA NEWS in Japanese Feb 87 pp 4-8

[Article by the Office of the Senior Officer for Development Programs, General Coordination Department, Agency of Industrial Science and Technology]

[Excerpt] Table 2. Outline of Plan for FY87 Big Project Research and Development

Project title: Manganese nodule mining system
FY86 budget (unit: 1,000 yen): 958,411
FY87 draft budget (unit: 1,000 yen): 819,047
R&D period--Total R&D expenditure: FY81-91--approximately 20 billion yen
Project overview: Will research and develop a fluid-dredge-type mining system which sucks up manganese nodules containing such important metals as nickel, copper, cobalt and manganese, along with sea water, from the ocean floor at depths of 4,000 to 6,000 meters in order to attempt a stable supply of nonferrous-metal resources.
FY87 major R&D plans: In regard to the total system, along with carrying out such things as study and detailed design of the system organization, will devise a program of comprehensive ocean tests.
In regard to each of the subsystems: the ore-gathering system, the ore-raising system, the handling system and the measuring-control system, will carry out detailed design and production of comprehensive ocean tests.

Project title: High-speed computation system for use in science & technology
FY86 budget (unit: 1,000 yen): 2,888,786; General account 1,236,991; Special account for electric power source development and promotion measures 1,288,481; Coal mining industry special account 363,314
FY87 draft budget (unit: 1,000 yen): 2,946,767; General account 887,463; Special account for electric power source development and promotion measures 1,719,304; Coal mining industry special account 340,000
R&D period--Total R&D expenditure: FY81-89--approximately 23 billion yen
Project overview: Will research and develop an integrated system which uses high-speed elements and a parallel-processing mode in order to process large science and technology computation such as processing of image-data sent from artificial satellites and simulation of the plasma of nuclear-fusion reactors.
FY87 major R&D plans: Will carry out research on advancement (development of practical circuits and enhancement of reliability) of such high-speed

elements as Josephson-connection elements and gallium arsenide elements, and on the parallel-processing mode.
In addition, as an integrated system, will carry out detailed design of the system and of a descriptive language for parallel processing, and will carry out research on the packaging system.

Project title: System for automatic sewing
FY86 budget (unit: 1,000 yen): 1,340,614; General account 133,855; Portion allotted to the Small and Medium Enterprise Agency 1,206,759 (of which 280,101 is for the Small Business Corporation)
FY87 draft budget (unit: 1,000 yen): 1,300,809; General account 133,351; Portion allotted to the Small and Medium Enterprise Agency 1,167,458 (of which 260,800 is for the Small Business Corporation)
R&D period--Total R&D expenditure: FY82-89--approximately 13 billion yen
Project overview: In regard to the clothing industry, will research and develop, through the introduction of mechatronics technology and so on, an automatic-sewing system which carries out efficiently the multiple-variety, small-lot production of small and medium sewing businesses in order to deal with such things as diversification of consumer needs and a change to short cycles in the clothing industry.
FY87 major R&D plans: Will carry out operation-simulation research concerning the total system.
Furthermore, in regard to requisite technology, will test-manufacture the main prototypes for each requisite technology: preliminary processing for sewing, sewing assembly, handling of cloth and system-management controls, and will make an interim evaluation.

Project title: Robot for work under extreme conditions [kyokugen sagyo]
FY86 budget (unit: 1,000 yen): 2,405,038; General account 367,569; Coal mining industry special account 1,037,000; Special account for electric power source development and promotion measures 1,000,469
FY87 draft budget (unit: 1,000 yen): 2,424,754; General account 350,570; Coal mining industry special account 943,111; Special account for electric power source development and promotion measures 1,131,073
R&D period--Total R&D expenditure: FY83-90--approximately 20 billion yen
Project overview: Will research and develop robots which perform extremely diverse and complicated field work such as inspection, maintenance and rescue activities in such fields as atomic power, oceans and disaster prevention swiftly and surely by means of direction from remote locations and so on under conditions in which entry is difficult due to radiation, high water-pressure, high temperatures and so on.
FY87 major R&D plans: Will carry out such things as basic experiments and detailed design regarding basic technology which is common to each field.
Furthermore, will carry out conceptual design concerning the total system, along with carrying out such things as detailed design and trial-manufacture experiments for requisite technology which is peculiar to robots in the atomic-power and ocean fields.

Project title: System of observation for use in resource-investigation
FY86 budget (unit: 1,000 yen): 4,391,052; 179,420; 4,211,632
FY87 draft budget (unit: 1,000 yen): 3,141,932; 181,932; 2,960,000
R&D period--Total R&D expenditure: FY84-90--approximately 23 billion yen
Project overview: Using artificial satellites, will research and develop a system of observation for use in resource-investigation, the main objective of which is investigation of petroleum resources, and will attempt to firmly establish the technology required for the design and (manufacturing sector) [seisakuku] of an observation system for use in Earth Resources Satellite Number 1 (ERS-1), which is scheduled for launching in FY90.
FY87 major R&D plans: Since it aims at completion as a total system of the observation system (sensor system and data-transmission system) which will be loaded on Earth Resources Satellite Number 1 (ERS-1), which is scheduled for launching in FY90, along with manufacturing an engineering model (EM) of each system, will study system-integration and a plan for system testing.
Furthermore, will carry out research on a geological remote-sensing system and necessary research and development of requisite technology concerning high-performance sensors.

Project title: System for integrated reclamation and utilization of water
FY86 budget (unit: 1,000 yen): 1,071,590; 320,248; 751,342
FY87 draft budget (unit: 1,000 yen): 2,122,514; 517,323; 1,605,191
R&D period--Total R&D expenditure: FY85-90--approximately 11.8 billion yen
Project overview: Will apply biotechnology and membrane-separation technology to research and develop an integrated system for reclamation and utilization of water which is radically different from those up to now in order to deal with such societal problems as an increasing tightness in the water supply over the medium to long term.
FY87 major R&D plans: Along with conducting research and development on microorganisms, separation membranes, bioreactors and measuring-control technology, will trial-manufacture small devices which combine membrane modules with bioreactors and so on. Furthermore, in regard to the total system, will carry out a survey, supporting research and so on involving Japan's fermentation of methane.

Project title: System for time-sharing computer data base
FY86 budget (unit: 1,000 yen): 830,683
FY87 draft budget (unit: 1,000 yen): 1,054,853
R&D period--Total R&D expenditure: FY85-91--approximately 15 billion yen
Project overview: As preparation of the foundation for an advanced information-society, will research and develop technology for building on a network in which time-sharing of computers is possible a distributed-data-base system which is highly reliable in dealing with multimedia.
FY87 major R&D plans: Along with setting to work on the conceptual design of the basic method concerning the requisite technology in distributed-data-base technology, multimedia technology, high-reliability technology and time-sharing-network system technology, will carry out partial trial-manufacture.
Furthermore, will set to work on devising a system of evaluating proof for the basic method, which will be carried out in the next fiscal year.

Project title: System for ultra-leading-edge processing
FY86 budget (unit: 1,000 yen): 20,000
FY87 draft budget (unit: 1,000 yen): 1,100,058; General account 375,645; Special account for electric power source development and promotion measures 724,413
R&D period--Total R&D expenditure: FY86-93--approximately 15 billion yen
Project overview: Will research and develop excimer-laser, ion-beam and ultra-precision machine-processing technology which is capable of carrying out the ultra-precision processing, ultra-minute processing and ultra-high-quality surface processing required in all such leading-edge fields as energy, precision machinery, electronics, aeronautics and space.
FY87 major R&D plans: Along with developing the requisite technologies of high-output-excimer-laser technology, high-density-ion-beam technology, ultra-precision machine-processing device technology, ultra-leading-edge processing technology and support technology, will carry out conceptual design of the total system.

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KDD VS. 'SECOND KDD,' TECHNOLOGICAL, CORPORATE STRATEGIES DISCUSSED

Tokyo ZAIKAI TEMBO in Japanese Sep 86 pp 136-146

[Article: "Self-confidence and Uneasiness of KDD To Undergo Challenge From 'Second KDD,' Formidable Enemy"; first paragraph is editorial introduction]

[Text] How will the Kokusai Denshin Denwa Co. (KDD), which has been enjoying a monopoly so far, deal with a pincer attack by the leading Japan-U.S.-U.K. enterprise group, consisting of the defunct financial combine centered on the Mitsubishi Corp., Mitsui & Co., Ltd., Sumitomo Corp., C. Itoh & Co., Ltd., Toyota Motor Corp., General Motors Corp. (GM), and Cable and Wireless PLC (C&W)?

Reduction of Charge Scheduled for This Autumn, Setting "Target" at Second KDD

When the Ministry of Telecommunications became the Nippon Telephone and Telegraph Corp. in 1953, its international branch only became an independent firm. This was the "start" of KDD. In other words, KDD was set up on 24 March based on the "Kokusai Denshin Denwa Kabushiki Kaisha Law" and inaugurated as an enterprise on 1 April. At that time, the economy of our country was devastated and it was urgent to expand trade in order to help the industrial economy recover rapidly. However, the communications situation was terrible and there was an earnest aim to catch up with the level of the United States and European countries.

Since then, KDD has been solely engaged in the international communications of our country as a private monopolistic enterprise and has taken the lead in the world in the areas of facilities, technology, and service.

In recent years, the domestic communications business is making progress at an annual rate of 4-5 percent, which means that the business is in a period of stable growth. On the other hand, the international communications business is experiencing rapid growth as a reflection of Japan's internationalization. Furthermore, the frequency of international telephone use increased three times over the last 5 years and income increased 83 percent; thus a high level of growth has been recorded. In addition to the fact that the Japanese people have more opportunities to go abroad and the use of the international telephone has increased, facsimile communications and data communications instead of conventional telegraph and telex are showing rapid growth.

KDD will reduce its international communications charge this autumn. The main points are:

1. The telephone charge will be based on the gradual-decrease formula by which the longer you use telephone, the greater the reduction of the charge will become.

2. The charge for a dial telephone call to the United States, the most popular call, will be reduced more than 20 percent.

3. The charge for an exclusive international telephone line to the United States will be reduced more than 30 percent. This will become effective 1 September.

KDD has reduced the communications charge almost every year since 1979, the seventh time this has happened. The reduction of the charge the past six times marked a one-digit level of 6-9 percent each time, but the original funds needed for this amounted to about ¥80 billion. This represents the fact that a portion of the enterprise's profit was restored to users in the form of a reduction of the charge. The so-called sense of mission to provide a "cheaper charge," assuming a smooth expansion of business, was the background for the reduction of the charge up to this time.

Of course, management's mission is a fine thing, but the seventh reduction in the charge scheduled for this autumn is intended to correct the situation in which the communications charge for telephone calls from Japan has become comparatively high because of the rapid appreciation of the yen and, on the other hand, to provide competition to the rival "second KDD."

The charge for telephone calls to the United States occupies 30 percent of KDD's annual telephone charge income (¥142.3 billion in FY 1985) and is expected to remain a moneymaker with sustained future demand. Therefore, with regard to the charge for telephone calls to the United States, a great reduction of 20 percent on the average is planned, but the rate of the reduction in the charge for telephone calls to Central America, Europe, etc. will be maintained at the one-digit level, with the rate of reduction for all international telephone calls held in check within about 10 percent.

In addition, with regard to the exclusive line, a reduction in the charge averaging 25 percent, including well over a 30-percent reduction in the charge for telephone calls to the United States and Asia, is planned. The monthly charge for calls to the United States per circuit, ¥1.3 million, will be less than ¥900,000.

"International Telecom Japan, Inc." (ITJ), the second KDD of the financial-combine group that started an enterprise on 1 July, participated anew in the field of exclusive lines as its first step. Therefore, KDD seized the initiative and intended to enlarge the reduction in the charge for exclusive lines. Needless to say, such a series of reductions will not go beyond the maximum permissible limit of financial management, but the equivalent of about ¥25 billion, corresponding to 10 percent of the entire income for FY 1986, is

said to be appropriated to reduce the charge. Therefore, it is said that great resolution will be needed.

KDD is determined not to yield one step and is preparing full-scale competition by means of "promoting the reduction in the charge through a further rationalization of management and technological innovation in the future." (President Takazo Ishii)

NTT and KDD To Be in Advantageous Position Even After Liberalization

In connection with the enforcement of the so-called "three telecommunications reform laws," including the Telecommunications Business Law and the Nippon Telegraph and Telephone Corporation Law, in April 1985 the monopolistic structure of the domestic communications business collapsed and the telecommunications business finally entered the era of liberalization.

The Telecommunications Business Law is a law forming the nucleus of the telecommunications field in response to the advanced information society of the 21st century, which will replace the Public Telecommunications Law of the past. The greatest aim is to abolish the monopoly of the Nippon Telegraph and Telephone Public Corp. (the present Nippon Telegraph and Telephone Corp. [NTT] and KDD, and to bring about free competition at home and abroad.

As a result, in the domestic communications business field, the Nippon Telegraph and Telephone Public Corp. was privatized and became NTT on 1 April 1985. On the other hand, with regard to the Type-I telecommunications business, the private enterprise group called a new common carrier (NCC)--the so-called second NTT group, such as the second NTT consisting of the Kyocera Corp., Sony Corp., Ushio, Inc., etc.; Nippon Telecom of Japanese National Railways; Nippon High-speed communications of the Ministry of Construction and the Japan Highway Public Corp.; Tokyo Tsushin Network (TTN); etc.--has received a business authorization and will begin providing service in autumn if things go well.

Because new participants are feverish to such a degree, it is not strange for the general public to see that the business of having its own domestic communications circuit facility and of providing telephone service must be very profitable. However, this NCC business is not so profitable as the amateur thinks. This is because NTT will resolutely carry out the reduction in the charge in a competitive manner. At present, if the new participant lays the communications circuit, such as optical fibers, etc., between Tokyo and Osaka, tens of billions of yen are needed. Even so, one-third of the present telephone charge will pay the new participant fully. However, President Shinto of NTT, after calculating income and expenditures, stated that "NTT would also like to make an effort to reduce the charge on long-distance communications from ¥400 for 3 minutes at maximum to about ¥100."

In connection with the reduction in the charge for a long-distance call, NTT is secretly planning a great revision of the intracity telephone charge. There are such strong voices that "I do not intend the increase (of the intracity telephone charge), but 'rationalization' is necessary" (President Shinto) and "even if automation is conducted to minimize the human element, it would

be impossible to eliminate the deficit of the intracity telephone charge." In short, to speak in plain language, business will go wrong as long as there is no increase in the charge. When the great revision of the intracity telephone charge is realized, the loss by the reduction in the charge for long-distance calls will be covered and, in addition, the income and expenditures will change for the better dramatically and the financial base will also be strengthened remarkably.

It is pointed out that this is the reason why NTT "agreed" on the three telecommunications laws and "welcomed" the new participant.

If only the intracity telephone charge can be increased, it would be very simple for NTT to deal with "NCC." In proportion to this increase, it will be possible to increase the "access charge" to NCC, which will be connected with the intracity circuits, and even if a part of the new participant tries to "dump" without regard to "cost," it will be easy to respond to it.

On the other hand, although the international telecommunications field was liberalized in form, competitors did not appear and it was believed that the monopoly of KDD would last a long time.

As a result, the Federation of Economic Organizations understands that the user's common demand is to receive more diversified and advanced international telecommunications services) at a lower rate. In order to realize this, as in the case of domestic communications, the principle of competition should be introduced. This is part of the liberalization of international services, such as the circulation of money, transportation, distribution, and information communications, being promoted by the General Agreement on Tariffs and Trade (GATT), the Organization for Economic Cooperation and Development (OECD), etc. Also, it was pointed out that it is necessary to introduce the principle of competition based on liberalization from the standpoint of our country to hold fast to the free trade structure.

There were reasons the new participation was not realized. The first is the idea of the new law. The new law will give priority to domestic communications in the first place with regard to the license of the Type-I business dealers. When the business dealers, who produce real results in domestic communications, want to make inroads into international communications, they can do that if they send in an application for a change in the license. In short, in order to engage in the international communications business, first of all they have to show actual results in the domestic communications business. Even in this case, in the new law, there is a clause to adjust demand and supply and the Ministry of Posts and Telecommunications will judge whether to let them make inroads into international communications while considering the demand and supply situation.

The second reason is international fetters. There are two means in international communications: satellite and submarine cable. With regard to satellite communications, there is the International Telecommunication Satellite (INTELSAT). This was set up in August 1964 and there are two agreements: the governmental agreement and the operational agreement. According to the operational

agreement, only the telecommunications business enterprise designated by the government can become a signatory. In Japan, there is only one firm, which is KDD. As a general rule, only this designated business enterprise will be able to use INTELSAT. In the case of Japan, if government authorization is given, it is possible to use INTELSAT through KDD. However, in order to engage in international communications, it is necessary to conclude a business tieup with the communications business dealer of the partner country and the problem as to whether or not the partner country will accept the new participant remains.

On the other hand, in the case of the submarine cable, an international joint venture will be set up. Only the business dealer who provided the funds at the time of constructing the submarine cable network is supposed to use the cable as a general rule. As a result, the new participant will not be in a position to use it immediately. Therefore, as may be expected, KDD's monopolistic situation remains. In this way, it will be a difficult problem for the new participant to use either satellite or submarine cable. In this connection too, it is difficult to make inroads into international communications. In spite of the full opening of communications, the doldrums continue.

Deep Attachment for Establishment of Second KDD: Federation of Economic Organizations' Foresight and Design

However, the Federation of Economic Organizations, which has devoted itself intensely in the past to the concept of unifying the communications satellites or the concept of launching the satellite of the Federation of Economic Organizations, displayed much enthusiasm again for the introduction of the principle of competition into international communications and for the trend of "deregulation." As a result, according to the forecast of the Federation of Economic Organizations, which worked out a questionnaire, it is expected that the international communications market in 10 years will grow into a ¥1.29 billion market, five times as big as the present KDD. This reflects an aspect of foresight and design in order not to force the Ministry of Posts and Telecommunications to become conservative based on the demand and supply trend and, in addition, to encourage the new participant. As a matter of fact, according to the estimate of KDD, the size of the market will be half, no more than ¥560 billion. A 15-25 percent growth rate is expected in terms of the number of minutes used, but, at the same time, the growth in income will be less than 10 percent because the charge will be reduced. It is explained that ¥560 billion is the figure to be attained based on a 10-percent growth rate. As a matter of fact, under the high-growth economy of our country during the 1965-1979 period, the income in international communications recorded an increase of five times thanks to technological innovations such as the communications satellite and the submarine cable, but during the 1980-1985 period, the increase did not go beyond 2.8 times. Such being the case, as long as no dramatic change takes place in the demand structure, including the rapid popularization of the television telephone, for the next 10 years the growth expected by the Federation of Economic Organizations is said to be impossible.

The person concerned of a certain financial combine-affiliated trading firm points out that "the estimate of the Federation of Economic Organizations is the figure built up in order to cheer up the mood for the new participant. The estimate of KDD is more realistic."

Probably because the Federation of Economic Organizations itself cannot have confidence in this estimate, it indirectly desired the inroads of one firm, stating that "it is desirable that the number of business dealers who want to make inroads will not be many from the viewpoint of the scale of the market, the continued stability of the business, etc." We will mention it later, but it came to pass that two groups will make inroads as a consequence. Also, in order to help the new participant make inroads, (1) KDD should pay full attention not to impose an excessive burden on the new participant, who will use the INTELSAT satellite, as to the intermediation of the process for the approval of the earth station which will become necessary, the trust of the telecommunications business on the portion of the space to be used, etc., and, at the same time, it should clarify all rights and duties. When the new-participant business dealer uses the existing non-INTELSAT satellite or launches its own satellite, the state, while giving consideration to our country's long-term and comprehensive satellite utilization plan, should actively engage in the coordination of INTELSAT. KDD should actively engage in the transfer of the imperishable right of utilization (IRU) of submarine cable at a reasonable price to the new-participant business dealer who wants to obtain it by transfer. (2) KDD should make public as much as possible the information on the international telecommunications market, the telecommunications situation on the part of foreign countries, technological matters, and the knowhow of telecommunications network construction which will be needed by the new-participant business dealers. (3) When a request for domestic transmission business or for a connection with a domestic facility is submitted by the new participant, the domestic business dealers such as NTT should give full consideration to the request and make an expeditious response to it.

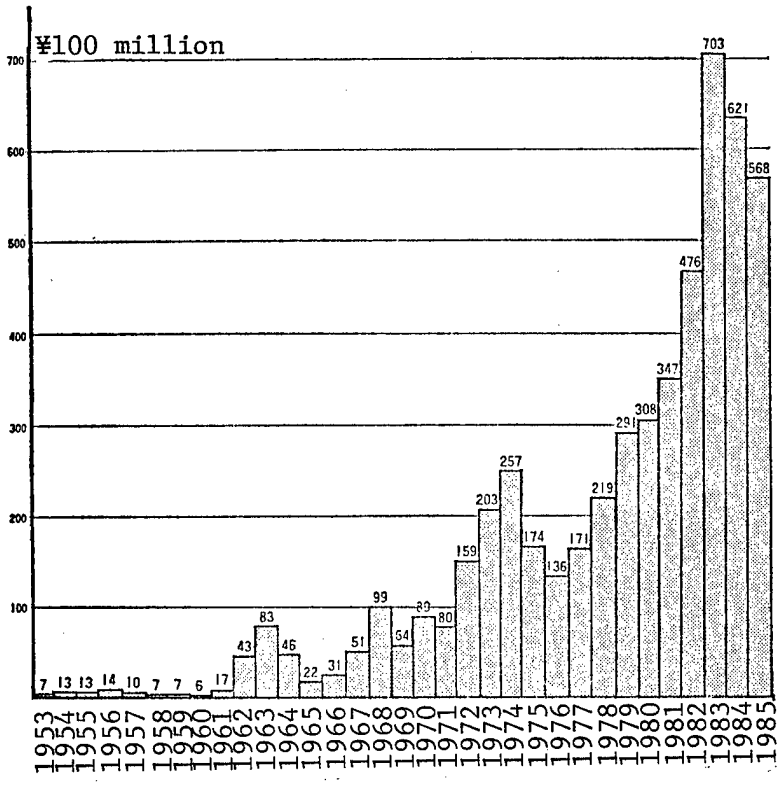
Such a well-prepared proposal to lower the "obstacle" has been made.

Speculation of Two Groups: Financial Combine Group and C. Itoh & Co., Ltd., Group

As in responding to the efforts of the Federation of Economic Organizations for the purpose of lowering the barrier against participation in international communications, the two groups have announced their intention of participation since this spring.

First of all, in April the financial combine-affiliated group, consisting of three trading firms, Mitsubishi, Mitsui, and Sumitomo, and, in addition, Matsushita Electric Industrial Co., Ltd., announced itself as the second KDD. Because there is not only the support of the Federation of Economic Organizations but also criticism by the U.S. Government of KDD's monopoly, the stage for realizing "the second KDD structure" is being built up so that the Ministry of Posts and Telecommunications can begin setting up a "study meeting to introduce the competitive system in the international communications field."

The fact that the Ministry of Posts and Telecommunications is scheduled to "review the communications liberalization policy in 2 years" has given the group to promote the second KDD momentum. On 1 July, the four firms played a leading role in setting up "International Telecom Japan, Inc.," a feasibility study firm in the international communications business.



Trend of Facility Investment

Capitalization of the new firm is ¥300 million, 18 percent of which will be invested by the three trading firms affiliated with the defunct financial combine and Matsushita Electric Industrial Co., Ltd., respectively; 12 percent by Marubeni Corp. and Nissho Iwai Corp., respectively; and 4 percent by the Bank of Tokyo. Nobuo Ito, an adviser to Mitsui & Co., Ltd., took office as president of the study firm and Yoshihiro Inayama became one of its promoters. In January of next year, the business firm will be set up and in April 1988 the firm is scheduled to begin providing service.

This preparation for setting up the second KDD as a business has been promoted on the basis of joining hands with Japanese enterprises. At the bottom of this concept, there is a logic peculiar to the financial world that a public business which is large-scale and is related to the national interest as is international communications should be promoted based on the collective will of Japan's industrial community. The belief that it is most effective to install the financial combine-affiliated enterprise as a nucleus, with the Federation of Economic Organizations playing the role of a "base camp," forms the mainstream in the financial world. The fact that the Nissho Iwai Corp. and Marubeni Corp., which was asked by C. Itoh & Co., Ltd., to make inroads, finally participated in the financial combine-affiliated group is said to have been based on such a sense of security.

In order to put forward the date to begin "service" as early as possible, the financial combine-affiliated group believes that the "borrowing" of the transponder of INTELSAT's satellite through KDD or the submarine cable of KDD is the

prerequisite of the plan. This is because the financial combine-affiliated group wanted to forestall the C. Itoh & Co., Ltd.-C&W of the United Kingdom group, get control over the limited circuits in the Pacific Ocean, and take the leadership. In its hurry, the group lost the opportunity to call on neutral big enterprises such as Nippon Steel Corp., Toyota, and electric power companies to participate, a move indispensable to organizing "all Japan." As the decision making of the combined group of four firms would be inevitably delayed, it was feared that seeking the participation of the big enterprises would cause further "speed-down." For this reason, for the time being, the request for participation was made to the Bank of Tokyo and Japan Air Lines Co., Ltd., using a large volume of international communications and other accumulated "knowhow."

However, when the concept of C. Itoh & Co., Ltd., surfaced, Japan Air Lines Co., Ltd., in order to stick to its neutrality, withdrew the plan completely and returned the anticipated investment share of 4 percent. There is a great possibility of big enterprises such as Nippon Steel Corp. and the Tokio Marine & Fire Insurance Co., Ltd., putting off investment in the two groups. On the other hand, another concept of the second KDD surfaced in June, 2 months after that. The participation of Toyota Motor Corp. and General Motors Corp. (GM) of the United States in the C. Itoh & Co., Ltd.-C&W group was made public. C&W is an enterprise that was set up to lay submarine cable between the United Kingdom and its colonies during the period of the British Empire. C&W at present has an independent communications network between the United Kingdom and Hong Kong.

C&W's earnest prayer is to set up a complete international network of its own. Based on this grand policy, it has a plan to lay a submarine optical cable between the United Kingdom and the East Coast of the United States at present and, in addition, is earnestly promoting the work of laying a cable across the continent of the United States. In July this year, the network connecting Boston on the East Coast and Los Angeles on the West Coast is scheduled to be completed.

Remaining is a project to lay cable between the West Coast of the United States and Hong Kong through Japan. C&W recently agreed with KDD to lay a submarine optical cable between Japan and Hong Kong with 1990 as a target date for completion. Remaining is a project to lay a similar cable between Japan and the West Coast of the United States. Preparations have already been made. This is the so-called P-PAC, for which C&W invested 20 percent and GM is also expected to invest in the future. A plan to lay an optical cable at the bottom of the Pacific Ocean was prepared and in early June, an application was submitted to the Federal Communications Commission (FCC). According to this application, the plan calls for the completion of as many as 60,000 circuits of the Pacific optical submarine cable by the latter half of 1989, with a total investment of $500 million.

Meanwhile, C. Itoh & Co., Ltd., laid the groundwork for concluding a tieup between Japan, the United Kingdom, and the United States. This concept of the second KDD, if seen from the British side, will become part of the worldwide strategy of C&W, but if it is seen from the Japanese side, Japan is skillfully making use of the worldwide strategy of C&W on the strength of restricting foreign currency.

In an effort to realize the second KDD concept, major trading firms visited C&W, but finally C. Itoh & Co., Ltd., was chosen. The conclusive factor was C. Itoh & Co.'s communications business results represented by its communications satellite. Also, C. Itoh & Co., Ltd., acted as a medium for GM to conclude a tieup with Isuzu Motor, Ltd., in the past. In addition, with regard to the communications satellite business, C. Itoh & Co., Ltd., engaged in the deal with the satellite of the Hughes Corp. The Hughes Corp. was taken over by GM. As a result, the friendship with GM became much more intimate. In addition, GM took over Electronic Data Systems (EDS), an information processing firm, as part of the project of its transformation into a "high-tech" enterprise. C. Itoh & Co., Ltd., concluded a tieup with EDS too and the relationship between C. Itoh & Co., Ltd., and GM deepened year by year.

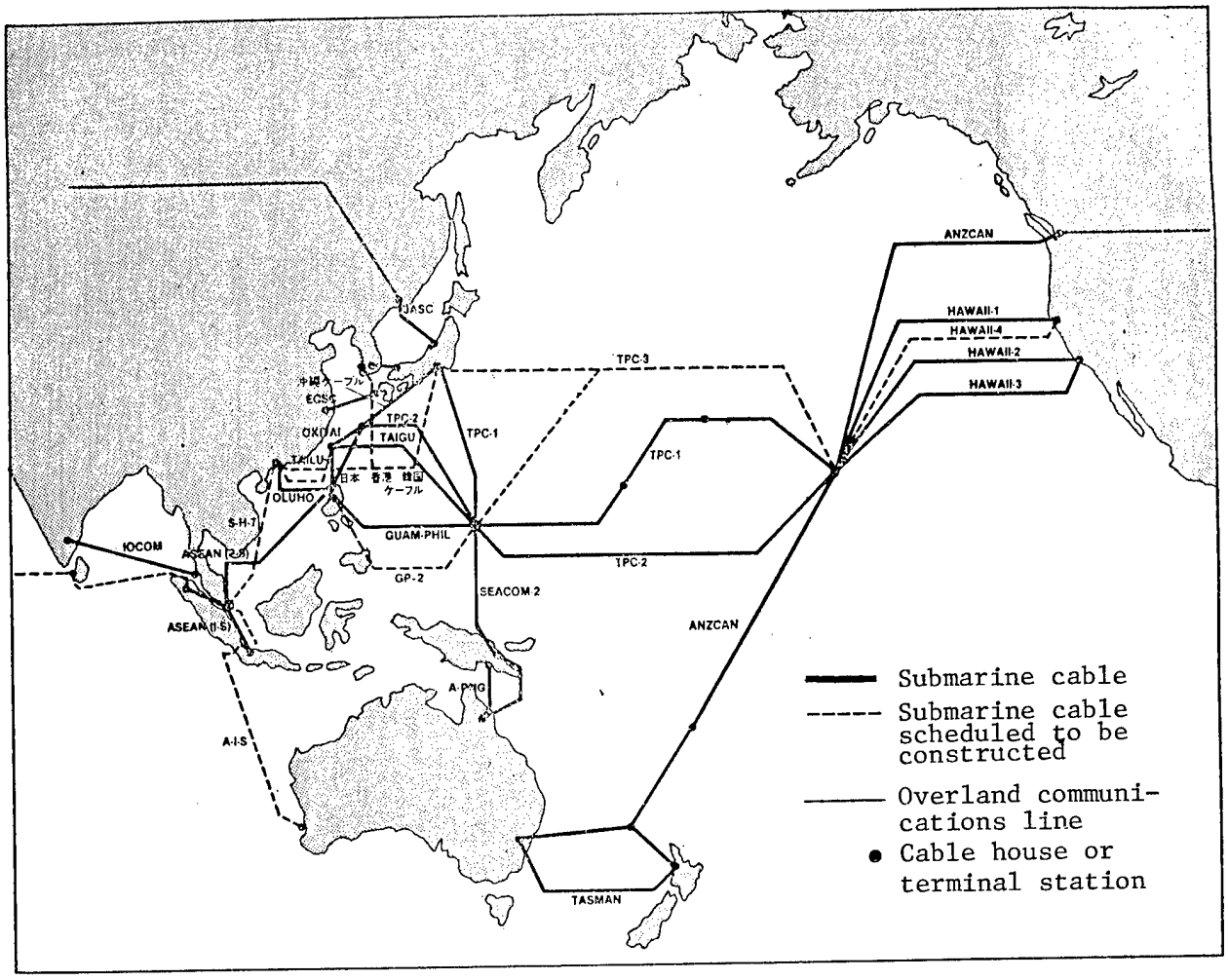
Toyota concluded a tieup with GM and is engaged in the joint production of small motor vehicles in the United States. It was 4 years ago that the tieup between GM and Toyota was concluded. C. Itoh & Co., Ltd., played the role of a mediator in the tieup of the century. To Toyota, too, the international communications business field is attractive. In response to foreign economic friction, direct investment overseas has to be actively promoted, and as a matter of course, the volume of communications to be used by its own firm will increase. Therefore, based on not only this concept of "save cost" but also other factors, the international communications business is believed to be a promising field of new business.

However, a study firm will be set up as early as August if things go well and a feasibility study will be conducted for about 6 months. The investment ratios of the key enterprises of the study firms are 30 percent by Toyota, 33.3 percent by C&W and GM, and 10 percent by C. Itoh & Co., Ltd. The four key firms occupy 73.3 percent of the whole, and communication equipment makers and financial organizations the remaining 26.7 percent. Also, the technological cooperation of NTT International, a subsidiary of NTT, will be provided for this concept of the second KDD. It is said that this is because NTT's cooperation is indispensable in landing the submarine optical cable. However, some even point out that this is an indication of the preparations for a tieup to be concluded with NTT in the future.

Fear of "Oversupply" of Communications Circuits Causes Concern

By the way, the problem is to procure funds for the new firm. At present, the Pacific submarine cable connects the West Coast of the United States with Tokyo through Hawaii and Guam. The distance between Tokyo and San Francisco is 17,000 km. The funds to lay a submarine optical cable are said to be ¥10 million per km. According to the computation based on this, the direct construction cost will be a little less than ¥170 billion, but if the cost for the survey in connection with the landing of the cable, construction costs, fishery compensation, etc., is included, a little less than ¥200 billion will be needed.

This will be shared equally by the United States and Japan. However, the Pacific line of the past was set up through Guam, but this time the line connects the West Coast of the United States directly with Tokyo through Hawaii. Therefore, the "merit" will be that this line will be 3,000 km shorter in length and cheaper in cost than the line through Guam.



Submarine Cables in the Pacific Area

Name of cable	Section
TPC-1 (No 1 Transpacific Cable)	Japan-Hawaii
TPC-2 (No 2 Transpacific Cable)	Japan-Hawaii
HAWAII-1 (California-Hawaii No 1 Cable)	CONUS-Hawaii
HAWAII-2 (California-Hawaii No 2 Cable)	CONUS-Hawaii
HAWAII-3 (California-Hawaii No 3 Cable)	CONUS-Hawaii
GUAM-PHIL CABLE (Guam-Philippines Cable)	Guam-Philippines
SEACOM-2 (British Commonwealth of Nations Southeast Asia Cable)	Guam-Australia
TAIGU (Taiwan-Guam Cable)	Taiwan-Guam
TASMAN (Australia-NewZealand Cable)	Australia-New Zealand
JASC (Sea of Japan Cable)	Japan-USSR
ECSC (Japan-China Submarine Cable)	Japan-China
OLUHO (Okinawa-Luzon-Hong Kong Cable)	Japan-Philippines Philippines-Hong Kong
OKITAI (Okinawa-Taiwan Cable)	Japan-Taiwan
Japan-South Korea Cable	Japan-South Korea

[continued]

[Continuation of Submarine Cables in the Pacific Area]

Name of cable	Section
A-PNG (Australia-Papua New Guinea Cable)	Australia-Papua New Guinea
ASEAN (P-S)	Philippines-Singapore
ASEAN (I-S)	Indonesia-Singapore
TAILU (Taiwan-Philippines Cable)	Taiwan-Philippines
ANZCAN	Australia-Canada Australia (Norfolk Island)-New Zealand
Okinawa Cable	Okinawa-Ninomiya (Kanagawa)
A-I-S (Australia-Indonesia-Singapore Cable)	Australia-Singapore
S-H-T (Singapore-Hong Kong-Taiwan Cable)	Singapore-Taiwan
SEA-ME-WE (Southeast Asia-Middle East-West Europe Cable)	France-Singapore
TPC-3 (No 3 Transpacific Cable)	Japan-Hawaii
Japan-Hong Kong-South Korea Cable	Japan-Hong Kong-South Korea
GP-2	Guam-Philippines

However, an oversupply of communications facilities is feared because the forecast for communications demand is not clear. AT&T and KDD are promoting the project to lay a submarine cable, "TPC-3," through Guam. The work will be completed in 1988, 1 year earlier than the schedule of C&W. The capacity is 40,000 circuits. If 60,000 circuits of the new firm, a 50 percent increase, are added to this, it is expected that the oversupply will be a source of fear. There are not a few people who worry that "it might not be possible that the oversupply will be eased even in the 21st century. It is expected that there will be a remarkable change in the demand structure and this is why the Federation of Economic Organizations sticks to its opinion that the number of the second KDD should be limited to one firm."

In addition, in contrast with KDD, the new firm has to promote the development of demand from now on. As this concept of the second KDD is large in scale, it is attracting a lot of attention by the mass media, but this might become the Achilles' heel in the stage of the feasibility study.

For this reason, as a measure to solve the problem, it is expected that the demand for the electrical transmission of pictures with great electrical transmission capacity will develop and that Tokyo will be used as a relay base connecting money markets of the world such as New York, Tokyo, Hong Kong, and London. In this respect, whereas the business of the financial combine-affiliated group is limited mostly to communications between the United States and Japan, the C. Itoh & Co., Ltd., group intends to set up a "global network" and, in anticipation of the prosperity of the Pacific economic zone, to conduct communications between the United States and the whole of Asia through Japan. This is a strong point.

In comparison with this, the concept of the financial combine-affiliated group begins with "borrowing" circuits. The international communications business is planned in terms of borrowing the right owned by KDD with regard to both

the communications satellite and the submarine cable. As a result of the fact that the group does not have a communications network of its own, facility investment is as small as ¥10-15 billion. In this sense it can be said that the group does not have a heavy burden. However, as the group will use the communications facility owned by KDD, the question remains as to whether or not "service" could be provided at a price lower than that of KDD. This is the reason why the Federation of Economic Organizations urged KDD to transfer the IRU of the cable at a reasonable price and to make public the knowhow. KDD promised to provide cooperation such as dispatching talented men to the study firm of the financial combine-affiliated group, but the plan of the group makes users feel weak compared with the plan of the C. Itoh & Co., Ltd., group.

On the other hand, the concept of C. Itoh & Co., Ltd., has a problem, which is different from the forecast of demand. PTC, a partner of the C. Itoh & Co., Ltd., group on the U.S. side, is, so to speak, a "readymade facility dealer" in communications facilities. PTC will not engage in the communications business by itself, but it will sell the communications network to users of the large enterprises such as the financial agency and the information processing service dealer.

In the United States, this self-supporting communications business has been liberalized, it is free to set prices by users, and there is no obligation to provide a "service" widely and impartially. In Japan, such a way of doing business has not been authorized, but a public obligation is imposed without exception and a charge is decided based on this authorization. That is to say, the business is treated as a Type-I communications business. A legal adjustment between the United States and Japan is anticipated to face the rough going ahead.

The PTAT plan between C&W and (Teleoptic) Co. of the United States and the TAV-1 plan of the SLC Co. of the United States calling for a transatlantic cable were authorized by the United States, but they were faced with the opposition of the European countries. Japan, the United States, and the United Kingdom are the only countries in the world where international communications have been liberalized. In Europe, the network is operated by the state without exception and there is a strong voice of opposition to the network being operated by a private business. The P-PAC plan by the C. Itoh & Co., Ltd.-C&W group is also a self-supporting international communications "bypass" and has a similar problem.

In Japan, liberalization was instituted as far as legislation is concerned, but actual operation has not yet been experienced. Whether P-PAC should be approved or not is one of the focal points of the future.

VAN Business Dealer To Be Competitive Partner Because of Liberalization of International VAN

On the other hand, aside from the second KDD, competition which cannot be disregarded is in store for KDD. That is the competition with the Type-II communications business dealer who has no facility, that is to say, the value-added network (VAN) dealer. About 200 firms have already made inroads into

the field of domestic communications. A situation similar to this will come into being in the field of international communications sooner or later.

In Japan, in an effort to realize an open-type VAN which will constitute a key "net," computer makers, independent VAN dealers, and the foreign dealer group as well as NTT have begun their activities. As Japan's internationalization advances, these open-type VANs will also be internationalized and become an international VAN.

Intec has already made inroads into the international VAN business jointly with the GTE Telenet Communications Co. of the United States. NEC Corp. has also begun to engage in the international VAN business in a tieup with the General Electric Co. (GE) of the United States. In addition, IBM and AT&T, two giants, have made inroads into Japan and fully intend to develop the open-type VAN. These firms are expected to advance into the international VAN business without exception.

KDD, which can use its own public data circuit (VENUS-P), has so far been the only firm to be able to develop the international VAN. This means that as there is a restriction based on the advisory opinion of the Council Committee of International Telegraph and Telephone (CCITT) that "the customers hiring a circuit will not be allowed to use it except for self-supporting communications," it is impossible for the customers to make inroads into the international VAN business by means of borrowing the exclusive line from KDD.

However, the Ministry of Posts and Telecommunications, by means of designating the international VAN business applicant dealer as RPOA (authorized private enterprise) in a special and exceptional measure, will not regard the dealer as a "customer" subject to the restriction of the advisory opinion. It is considering giving authorization for the international VAN business. This liberalization is expected to be realized as early as this summer if things go well. At the same time, VAN business dealers such as Intec will become KDD's formidable competitors.

Over against this, KDD will compete by means of the international data transmission service (VENUS-C), which is based on the circuit exchange formula suitable for exchanging and transmitting a greater volume of information than the public data transmission service "VENUS-P" based on the packet exchange formula initiated in February 1982. In addition, in February multi-media message communications system set up by incorporating the communications-processing function into the international communications network was developed. This is called a message handling system (MHS), which is capable of internationally transmitting and receiving various kinds of messages such as telex and facsimile. Based on this, it will be possible to realize almost all functions, including media conversion, that are necessary for the international communication of messages.

KDD introduced the technology of MHS into "VENUS-P," and thereby has begun this year a much higher level of service such as the "mail box," protocol conversion, broadcast communications, and media conversion.

What KDD aims at is the demand of "mail box." As far as international communications are concerned, the equipment with an accumulation function is better for communications because of the fact that there is a difference in time and in language. For this reason, the demand for "mail box" is believed to be great. The international VAN is said to become a "mail box" in the end. If so, the Type-I business dealer such as KDD and the international VAN business dealer will develop the "mail box" service in a melee. As a matter of fact, ITT of the United States will provide the "software" called "Diacom" to its tieup firms all over the world and has a strong desire to set up a worldwide network.

Measures To Intercept Rivals by Accumulation of Technology and Reform of Organization

KDD is jealously hammering out measures against not only the second KDD but also future competitors.

Above all, what attracts attention in the area of technological development is an integrated-service digital network (ISDN). In the Japanese version, it is an information network system (INS) being promoted by NTT. Its purpose is to present all kinds of communications services by means of a single network. In other words, this does not mean setting up a network for each service such as telephone, telex, and data transmission as has been done so far, but to present diversified services by means of digital signals through one network.

Upon completion, it will be possible to meet the needs of the telecommunications business, whose diversification is advancing, and also to reduce the investment in facilities and the cost of operation, maintenance, and care by means of jointly using such facilities in exchange, which will lead to a great reduction in cost.

With regard to ISDN, its concept came into being about 10 years ago at CCITT, but after that, its study has been promoted. As a result, a basic concept was almost firmed up about 2 years ago. At present, many countries in the world are promoting the development with the aim of setting up ISDN in their countries. In some countries, a test for practical use has been conducted. NTT is also promoting the experiment of the INS model at Mitaka. However, because of the fact that depending on the country, the technological standard of telecommunications is not the same and the situation of the communications network is different among other things, it is impossible to complete ISDN to connect the entire world.

KDD believes that it will take about 20 years at least to complete ISDN, which will expand on a worldwide basis. It is anticipated that the following three steps will be taken.

The first step is discrete digitalization: A discrete network such as a telephone network or a telex network will be digitalized after about 5 to 8 years from now and the base for setting up the international ISDN will be prepared. It is anticipated that upon completion of TPC-3 (No 3 Transpacific Cable), the digitalization of the transmission route will be promoted, and by about 1990, almost all communications facilities of KDD will be digitalized.

The second step is the integration of nontelephone-based service networks: This step is believed to cover the period until about 1995, during which time the integration of nontelephone-based service networks centering on the data network will be promoted. In this step, a partial ISDN with the countries in which the communications network has been developed will begin to be set up.

The third step is the completion of the worldwide ISDN: The discrete network of the past will be absorbed into ISDN and about the year 2000, an ultimate ISDN will be completed by means of a single integrated network.

KDD's New Start To Challenge the "Era of Competition"

Based on these plans, in February this year, KDD concluded a comprehensive business tieup, including joint development of ISDN, with AT&T and British Telecom (BT) of the United Kingdom. Judging from this, at the time of setting up the worldwide ISDN, it is believed that these three firms, including KDD, will play a leading role. The realization of ISDN is said to be the ultimate form of international communications. It is said that concerted action to be taken by the three firms will not only promote advancement in the international communications business but will also become an important factor in securing the superior positions of these enterprises from now on as well.

The measures for KDD to intercept the rivals which will appear are not limited to the technological aspect alone. President Ishii, who is leading the van, candidly spoke his mind when he said that "although I do not feel a bolt from the blue in the participation by the newcomers, I, as a manager concerned, recognize that 'a difficult situation' has come about."

However, a drastic reform of the management structure was conducted on 1 August for the first time in 6 years. Strengthening and expansion in the fields of business, management strategy, and R&D occurred, and, at the same time, 40 rooms and departments were reduced to 30 rooms and departments and a "slim" organization of the "type that can respond to competition" was worked out. In this manner, KDD is very active in strengthening its physical constitution.

Also, it is anticipated that not only a reallocation of employees but also a high-level facility investment amounting to about ¥65 billion annually in the next 4-5 years will continue. In addition, its contents will be reexamined and a forward-looking posture has been shown for a tieup to develop new businesses and open up new fields.

In recent times, KDD concluded tieups with MCI and GTE Sprint, both the "second NTT" of the United States. In the past, with regard to the international telephone line between the United States and Japan, great importance was attached to the friendship with AT&T and there was nothing but the KDD-AT&T circuit.

However, in order to respond to the era of competition, tieups were concluded with the two firms that will provide services at a price relatively lower than that of AT&T. Thus, the user's convenience has been promoted. In addition,

it is also hoped that MCI and GTE will avoid concluding tieups with other newcomers. In this manner, President Ishii places his principal point on the development of an active management strategy and strongly urges his men "to do away with the bad practice followed during the era of monopoly and to engage in the business without fearing that a mistake will be made." KDD is about to take a new step toward the 21st century.

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